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NATIVE LATEX COMMERCIALIZATION ACT OF 1978

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BEFORE THE

SUBCOMMITTEE ON DEPARTMENT INVESTIGATIONS, OVERSIGHT, AND RESEARCH

OF THE

COMMITTEE ON AGRICULTURE

AND THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

NINETY-FIFTH CONGRESS

SECOND SESSION

ON

H.R. 12559

JUNE 19, 1978

Serial No. 95-KKK
(Committee on Agriculture)

[No. 82]
(Committee on Science and Technology)

Printed for the use of the Committee on Agriculture
and the
Committee on Science and Technology

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1978

31-372 0

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NATIVE LATEX COMMERCIALIZATION ACT OF 1978

MONDAY, JUNE 19, 1978

HOUSE OF REPRESENTATIVES, SUBCOMMITTEE ON DEPARTMENT INVESTIGATIONS, OVERSIGHT, AND RESEARCH OF THE COMMITTEE ON AGRICULTURE, AND SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY, OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY,

Washington, D.C.

The subcommittees met, pursuant to notice, at 10:05 a.m. in room 1301, Longworth House Office Building, Hon. E de la Garza (chairman of the Subcommittee on Department Investigations, Oversight, and Research) presiding.

Present: Representatives Brown, Harkin, Skelton, Thornton, and Grassley.

Staff present: Eleanor Walsh, clerk; Bert Pena and Jerry Jorgensen, Subcommittee on Department Investigations, Oversight, and Research, Committee on Agriculture; Dr. John Holmfeld, staff, and Anthony Scoville, minority staff, Subcommittee on Science, Research, and Technology, of the Committee on Science and Technology.

Mr. DE LA GARZA. Good morning. The subcommittees will be in order.

While the other members are arriving, I would like to welcome all of you here, as well as the members of the Science and Technology Subcommittee who will be joining us to hold this joint session.

Today our combined subcommittees start a series of hearings which will center on the guayule plant. As all of us here know, guayule is one of the so-called new crops that the Department of Agriculture is conducting research on for the purpose of utilizing plant-derived resources.

I think it might be well to mention, briefly, that I first became acquainted with guayule directly when I was a young man in high school during the beginning of World War II. They had plantings and were doing research on guayule in my area near Mission and Edinburg.

In the summer, the high school team was hired to come work and weed in between the bushes. That was my first direct encounter with guayule.

We welcome you here, and we hope that this might be the beginning of something that can prove of benefit. It has to because if the Aztecs were using it 1,000 years ago, I am sure we can use it.

One of our major concerns was this: A major magazine about five or six editions back had a list of things we do not have in the United States. I was on the way down to make several speeches in my area,

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and one of the speeches I was going to make was to a service club there.

Their being an international organization, working on the relationships between nations and people, one of the persons there, who shall remain nameless, walked up to me and said, "When are we going to figure out that we don't need the rest of the world? When are we going to centralize on America? When are we going to tell the rest of the people that we don't need them?"

I had just read that article, so I dumped the speech I was going to make and read them the list of what we did not have starting with cobalt, of which we had no production, and Zaire had 93 percent of the world's production. I asked, "How many here know where Zaire is?"

I told them, "You know what cobalt is and what we use it for." I do not know whether they knew this either, but this fellow wanted to jump off the world and have America go it alone. Reading that list, it shocked me.

This is one of the areas high on the list. We have, at this time, no commercial production of natural latex in the United States. We have only 50 percent of the sugar. We have no coffee, no cobalt, very little magnesium, and certainly not enough of the oil that we need. We see the list of the countries that produce it, and this gives rise to some concern when you look at the strategic materials we need and the countries where they are produced.

Just read the paper any morning this week, and find out where we are.

With that, I welcome you all. Hopefully, this might be at least our intercession in the beginning of something that will be good for this country.

Maybe some day we can satisfy that gentleman who wanted to let the rest of the world go by and centralize on America. I guess that if we produce everything we need, we could do that, but at this time it cannot be done.

I had a more formal presentation I was going to make, but I did like I did on that speech at that service club. So, without objection, my written statement will appear in the record at this point.

[The prepared statement submitted by Mr. de la Garza follows:]

STATEMENT OF HON. E DE LA GARZA, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF TEXAS

First, I would like to welcome the members of the Science and Technology Subcommittee on Science, Research and Technology as well as all our witnesses and interested guests.

Today our Subcommittee on Department Investigations, Oversight and Research and the Subcommittee on Science, Research and Technology of the Committee on Science and Technology will meet for the purpose of conducting joint hearings on guayule.

As you know, guayule is one of our so-called "new crops" that the Department of Agriculture is conducting research on for the purpose of utilizing plant-derived resources.

To investigate new crops has, at no time, been more important to our Nation than today. In the past, we have not been concerned over the supply of industrial raw materials and agricultural research has overwhelmingly emphasized food crops. However, as nonrenewable resources have become more difficult and expensive to obtain, we have now sharpened our focus on plant-derived (renewable) resources to supply our industries' needs and maintain our national pro-

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ductivity. Therefore, it is urgent that we turn to crops such as guayule in order that we can guarantee the Nation's industry domestic supplies of organic raw materials.

Natural rubber is a commodity which is vital to our economy, defense, and general well-being. All of the world's supply of natural rubber is manufactured from latex of the Hevea tree, 93 percent of which is produced in Southeast Asia. The United States imports nearly a million tons of this material annually at a cost of a half-billion dollars.

Natural rubber makes up about 35 percent of our total rubber consumption, the remainder coming from synthetic rubber. Synthetic rubber is made from petroleum.

While the Hevea tree is a tropical species not at all suited to temperate regions, there exists another group of plants belonging to the genus Parthenium, which are native to Texas and Mexico, and which contain commercial quantities of a very high quality latex. These plants are commonly called guayule. Guayule has been recognized for many decades as a latex producer and during World War II the U.S. Government undertook a sizeable research and development program to cultivate this plant in the Southwest and manufacture rubber from it.

A well organized research and development program could result in a commercially viable guayule latex industry in this country.

If a guayule industry could be established, it could help reduce the Nation's foreign made deficit and reduce our foreign dependence on overseas rubber sources during periods of international crisis.

I also believe that successful commercialization of rubber production from the guayule bush would help develop jobs in areas that now have no industry. I believe it would also help us reduce the use of petroleum in making synthetic rubber.

Mr. DE LA GARZA. I recognize my cochairman in this hearing, the Honorable George Brown of California.

STATEMENT OF HON. GEORGE E. BROWN, JR., A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Good morning, ladies and gentlemen.

I am delighted to join with Chairman de la Garza in cochairing this 1-day hearing on H.R. 12559, which was jointly referred to the Agriculture Committee and the Science and Technology Committee.

Mr. de la Garza has been a leader in the Congress in advancing our Nation's agricultural research. Most recently he was instrumental in enacting into law the important research title in the 1977 Food and Agriculture Act. As a member of Mr. de la Garza's subcommittee, I look forward to working under his leadership on this important bill.

Today I am also wearing a different hat, that of Acting Chairman of the Science, Research and Technology Subcommittee of the Science and Technology Committee. The regular chairman of that subcommittee, our colleague Ray Thornton, shares with myself and Mr. Harkin of Iowa the distinction of being the only members of the House who are members of both the Science Committee and the Agriculture Committee. Mr. Thornton is himself a strong supporter of agricultural research, and I want on this occasion to thank him for asking me to serve as acting chairman of his subcommittee on this bill.

I want to emphasize that as a sponsor and co-sponsor of the several guayule bills before us, and as one who has had a long-standing interest in this subject, I still have many questions about it. Personally, I am not wedded to any one of the provisions of these bills, and I am very hopeful that through the testimony and the questions and answers which we will hear today, we will be able to clarify many of those questions. I will say, Mr. Chairman, that, in my opinion, we

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should not exclude the possibility that we may find it worthwhile to rewrite the bill substantially, and perhaps even go to a clean bill.

At the start of the afternoon session, I will make some further remarks about the substance of the bills, but for now I will be content to listen.

Thank you, Mr. Chairman.

Mr. DE LA GARZA. I ask unanimous consent that the statement prepared by the ranking minority member of the Science, Research, and Technology Subcommittee, the Honorable Harold C. Hollenbeck of New Jersey, be printed in the record at this point.

[The prepared statement submitted by Mr. Hollenbeck follows:]

STATEMENT OF HON. HAROLD C. HOLLENBECK, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW JERSEY

Thank you, Mr. Chairman. I, too, wish to join in support of H.R. 12559, to undertake research and development of guayule rubber. As noted this morning, contrary to the belief so prevalent after the Second World War, synthetic rubber has not completely supplanted natural rubbers, and indeed about one-third of world rubber production consists of natural rubber, most of it coming from Hevea grown in Southeast Asia. As is the case with many of our minerals and materials, the United States is almost totally dependent upon foreign sources for its supplies of natural rubber.

Even were the nations of Southeast Asia to assure us of supplies for the foreseeable future, there are additional dangers. For example, the chance introduction of the South American leaf blight into Southeast Asia would make it virtually impossible to cultivate rubber in Southeast Asia and would thus cut short all supplies. This bill, for research and development of guayule, is important for the further reason that it could provide the World with alternative and varied sources of rubber. If successful, it would leave us less vulnerable to the vagaries of changing political and biological conditions.

Taking a broader perspective, I recently introduced legislation to establish comprehensive materials planning policy relating technological change to materials planning. As a result of that work, I have become aware of the importance of variety and substitutability within our materials system as a way for countering unexpected changing conditions. In sum, Mr. Chairman, I commend this bill. It is an important example of the recognized need to anticipate alternative sources of materials. H.R. 12559 is of importance not only to the Southwest where it may increase agricultural productivity in semi-arid areas, but nationally for possible sources of rubber supplies. It is a commendable attempt to forecast the need for varied sources and resources of critical materials upon which our nation depends.

Mr. DE LA GARZA. I would also have inserted in the record at this point, without objection, a copy of the bill, H.R. 12559 and the Department's letter of June 12, 1978, which we are about to discuss.

[H.R. 12559 and the report from the U.S. Department of Agriculture follow:]

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95TH CONGRESS
2D SESSION

H. R. 12559

IN THE HOUSE OF REPRESENTATIVES

MAY 4, 1978

Mr. BROWN of California (for himself, Mr. DE LA GARZA, Mr. FOLEY, and Mr. TEAGUE) introduced the following bill; which was referred jointly to the Committees on Agriculture and Science and Technology

A BILL

To establish a research and development effort resulting in the commercialization of native latex rubber.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Native Latex Commercialization Act of 1977".

SEC. 2. Congress recognizes that natural latex rubber is a commodity of vital importance to the economy, defense, and general well-being of the Nation. The United States is totally dependent upon foreign sources for its supplies of natural (Hevea) latex, which total about one million tons per year. Synthetic rubber, which is manufactured from petroleum feedstocks, cannot be substituted for natural

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rubber. The Congress further recognizes that certain plant species of the genus Parthenium, native to Texas and Mexico, as well as other plants, are known to contain commercial quantities of extractable latex. During World War II, through research carried out in the emergency rubber project, the United States demonstrated that Parthenium latex is a promising and realistic substitute to Hevea latex. Further research and development are needed, especially into methods for increasing latex yields, before commercialization of native Parthenium latex by private industry is feasible. Such commercialization would not only relieve the Nation's dependence upon foreign latex sources, but it would also provide a valuable cash crop for arid and semiarid regions of the United States and additional industry and employment opportunities for people of the United States. It is the policy of Congress, therefore, to provide for the development and demonstration of economically feasible means of culturing Parthenium, and other hydrocarbon-containing plant species, for the extraction of commercial latex and other products.

SEC. 3. As used in this Act—

(1) The term "Secretary" means the Secretary of Agriculture.

(2) The term "State" means each of the fifty

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States, the District of Columbia, and the Commonwealth of Puerto Rico.

(3) The term "commercialization" refers to the stage in the development or advancement of a technology at which point private enterprise is willing to invest in a full scale production facility.

(4) The term "native" refers to hydrocarbon-containing plants which may be cultured in North America, especially members of the genus Parthenium (known as Guayule).

SEC. 4. The Secretary of Agriculture (hereinafter referred to as the "Secretary") is authorized and directed to coordinate and carry out research leading to and culminating in the commercialization of latex from Parthenium or other hydrocarbon-containing plants.

SEC. 5. The Office shall conduct, promote, and sponsor basic and applied research, technology development, and technology transfer leading to effective and economical methods for large scale culturing of plantations and the extraction and production of latex from such crops. Such research will include, but not be limited to—

(1) carrying out extensive seed collections from wild plants in Texas, Mexico, and other areas and borrowing or purchasing seeds from other sources;

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(2) developing a stockpile of Parthenium seeds, such stockpile to be appropriately classified and stored at a suitable facility;

(3) carrying out breeding and selection programs for the purpose of improving latex yields, expanding insect and disease resistance, and broadening the ranges of drought and cold tolerance of the Parthenium plant;

(4) establishing a system of experimental plantings in arid and semiarid regions of the United States having suitable climatic and soil conditions for the culture of Parthenium;

(5) carrying out specific studies on the effects of irrigation on plant growth and latex yield and survival potential;

(6) developing equipment needed to carry out nursery operations, planting, cultivating, harvesting, transporting the crop, and other necessary agricultural activities;

(7) further refining present extraction and manufacturing technologies; and

(8) analyzing the economic feasibility of private production and manufacture of native Parthenium latex.

SEC. 6. The Secretary shall establish and maintain a bank of all pertinent research data on native latex including extant United States Government publications and records

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from the emergency rubber project. Such data shall be made available to other Federal and State agencies and private persons who are interested or involved in native latex research, development, or manufacture.

SEC. 7. The Secretary is authorized and encouraged to enter into cooperative projects with the Government of Mexico in order to accomplish appropriate aspects of the research and development provided for in this Act. Such cooperative projects shall include, but not be limited to, projects to determine the economic feasibility of latex extraction and processing.

SEC. 8. The Secretary is authorized to accept financial or other assistance from any State or public agency to aid in carrying out the provisions of sections 5, 6, and 7 of this Act and to enter into contracts with respect to such assistance and to enter into agreements with any State or public agency for the purpose of demonstrating, transferring, or applying results of research relating to native latex.

SEC. 9. In carrying out the provisions of this Act, the Secretary is authorized to—

(1) make grants to educational institutions and scientific organizations and enter into contracts with such institutions and organizations and with industrial or engineering firms;

(2) acquire the services of biologists, agronomists,

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geneticists, chemists, engineers, economists, and other personnel by contract or otherwise;

(3) utilize the facilities of Federal scientific laboratories;

(4) establish and operate necessary facilities, pilot plants, and plantations to carry out the continuous research, testing, development, and programing necessary to effectuate the purposes of this Act;

(5) acquire secret processes, technical data, inventions, patent applications, patents, licenses, land, and interests in land (including water rights), plants and facilities, and other property or rights by purchase, license, lease, or donation;

(6) assemble and maintain pertinent and current literature and publications, patents and licenses, land and interests in land;

(7) cause onsite inspections to be made of promising projects, domestic or foreign, and, in the case of projects located in the United States, cooperate and participate in their development when the Secretary determines that the purpose of this Act will be served thereby;

(8) foster and participate in regional, national, and international conferences relating to native latex culture or manufacture;

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(9) coordinate, correlate, and publish information with a view to advancing the development of native latex technology; and

(10) cooperate with other Federal departments and agencies, with State and local departments, agencies, and instrumentalities, and with interested persons, firms, institutions, and organizations.

SEC. 10. In carrying out the provisions of this Act, the Secretary shall insure that his activities are closely coordinated with the activities of other Federal agencies such as the Department of the Interior, National Science Foundation, Department of Commerce, Bureau of Indian Affairs, Federal Energy Administration, Energy Research and Development Administration, Economic Development Administration, Department of Defense, Treasury Department, Federal Preparedness Agency, and others in order to prevent duplication of effort, ensure compatibility with ongoing programs and policies, and to fully exploit the opportunities inherent in the culture and manufacture of native latex.

SEC. 11. Relative to the definitions of, title to, and licensing of inventions made or conceived in the course of or under any contract or grant pursuant to this Act, and notwithstanding any other provisions of law, the provisions of sections 9 and 10 of the Federal Nonnuclear Energy Re-

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search and Development Act of 1974 (42 U.S.C. 5908–9) shall govern.

SEC. 12. The Secretary may dispose of any latex, resin, wax, pulp, and any other byproducts resulting from operations under this Act. All moneys received from dispositions under this section shall be paid into the Treasury as miscellaneous receipts.

SEC. 13. The Secretary may issue rules and regulations necessary to effectuate the purposes of this Act.

SEC. 14. The Secretary shall submit to the President and the Congress, no later than December 31, 1979, and each year thereafter through 1981, a report on the status of the research, development, and other work underway under sections 4, 5, 6, 7, and 8 of this Act. Such report shall (1) recommend specific directions for further research, development and other work, and (2) recommend funding levels for various elements of the overall project.

SEC. 15. There is authorized to be appropriated for the fiscal years beginning October 1, 1977, through October 1, 1981, the sum of $60,000,000 to carry out the purposes of this Act, such sum to remain available until expended.

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DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

June 12 1978

Honorable Thomas S. Foley
Chairman, Committee on Agriculture
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

This is in response to your request for a report on H.R. 12559, a bill "To establish a research and development effort resulting in the commercialization of native latex rubber".

This Department recommends that the bill not be enacted until the foundation for a program can be justified on the basis of a feasibility study.

The legislation if enacted would direct the Secretary of Agriculture to coordinate and carry out research leading to and culminating in the commercialization of latex from Parthenium (Guayule) or other hydrocarbon-containing plants. The Secretary would be further authorized to establish a bank of all pertinent research data on native latex, to enter into cooperative projects with the Government of Mexico, to accept financial or other assistance from any State or public agency, as well as to make grants to educational institutions and scientific organizations. The Secretary would be further directed to submit to the President and the Congress by December 31, 1979, and annually through 1981 a report on the status of the research, development, and other work authorized by sections 4, 5, 6, 7, and 8. The bill provides an authorization of appropriations for the fiscal years beginning October 1, 1977 through 1981, in the amount of $60 million for carrying out this Act.

While the program outlined in H.R. 12559 is in keeping with some specific recommendations contained in the report of the National Academy of Sciences entitled, "Guayule: An Alternative Source of Natural Rubber," H.R. 12559 does not accord entirely with the spirit of those recommendations. The report recommended a feasibility study, technology assessment, and environmental-impact analysis of guayule. We believe these steps to be essential before recommending

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enactment of a program with a proposed authorization of appropriations of $60 million. Funding needs to undertake a program of Parthenium research, such as the one suggested in the National Academy of Sciences study, would be best established through the budget process, where the program's resource needs would be judged in competition with other research priorities.

This Department has previously been involved in investigations of guayule. USDA was responsible for administration of the Emergency Rubber Project during World War II and continued investigations in culture and breeding of guayule until 1959. Promising advances were made in yield, rubber quality, and cultural practice. The programs were terminated, however, because development of guayule as a crop of economic importance in the United States could not be demonstrated at that time in face of low cost synthetic rubber and the world supply of natural rubber from other parts of the world.

Awareness of the ultimately limited supply of fossil fuel for chemical feedstocks and increasing U.S. dependence on foreign sources for materials suggest the need for reevaluation of the potential of agriculturally renewable resources as supply for critical materials needs. With this motivation, experimental breeding plots and new collections of genetic materials have been initiated recently at the University of Arizona and the Los Angeles Arboretum. In Mexico and Israel research projects are underway.

The Office of Management and Budget advises that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely,

P. R. "Bobby" Smith
Acting Secretary

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Mr. DE LA GARZA. This morning, we are happy to have as our first witness Mr. David Unger, Acting Deputy Assistant Secretary for Conservation, Research, and Education of the U.S. Department of Agriculture.

We welcome you here and will be very happy to hear from you at this time, Mr. Secretary.

Mr. UNGER. Thank you, Mr. Chairman.

I am accompanied this morning by Dr. Andrew Cowan who is a scientist with the Federal Research part of our Science and Education Administration.

We are happy to provide you with the views of the Department of Agriculture concerning H.R. 12559 and H.R. 5720.

I would like to ask, if it is appropriate, that our statement be entered in the record in its entirety, in the interest of saving time, if that is satisfactory with the chairman.

Mr. DE LA GARZA. That is quite satisfactory.

Without objection, your full statement will appear at this point in the record.

[The prepared statement submitted by Mr. Unger follows:]

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STATEMENT OF DAVID G. UNGER

Acting Deputy Assistant Secretary of Agriculture
for Conservation, Research, and Education

We appreciate this opportunity to testify before the Committees on H.R. 12559 and H.R. 5720. Since these two bills are identical in text, the following statement will apply to both. These bills would "establish a research and development effort resulting in the commercialization of native latex rubber."

I am sure that in this hearing there will be statements presented from scientists other government agencies and from industry, on the research needs and developmental efforts required for an orderly and systematic movement toward commercialization of guayule. I will not dwell at length with these matters except to say that there are certainly appropriate research and development roles for industry and State and Federal institutions to play in this development of a new crop.

The Department of Agriculture, while not opposed to a comprehensive guayule research and development effort of significant proportions, considers that the bill should not be enacted until the program is justified on the basis of a feasibility study as recommended by a report published by the National Academy of Sciences in 1977. Economic analysis, the costs benefits and technological and social impacts should be fully explored before a Federal commitment of resources is made to develop and commercialize native latex rubber.

The Department recognizes that a number of factors point to the desirability of guayule development. Among these are:

The opportunity for development of a new commodity crop that potentially can provide income from land in areas where it is badly needed.

The critical dependence of the Nation on imported natural rubber.

The projected scarcity of petrochemical resources for synthetic rubber.

The recent increase in emergency stockpile requirements for natural rubber.

These factors, however, have not been translated into an urgency for development that overrides an orderly development program leading to an economically viable enterprise.

Background

It was estimated in 1905 that guayule grew wild on approximately 18,200,000 acres, most of which were in Mexico. Rubber was produced from harvest of this plant in wild stands in Mexico from 1904 until

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1912, at which time the accessible supply of the wild shrubs began to run low The International Rubber Company attempted to commercialize production of cultivated guayule rubber in California and Arizona in the period 1931 to 1941. The record indicates that about 8,000 acres were planted and that from this, during the 10-year period, approximately 1,400 long tons of raw rubber were produced. Shortly after the Government implemented its programs as a result of the War Emergency Act passed in 1941 the company's physical assets were purchased in 1942. The emergency program on production of guayule rubber was assigned o the U.S Department of Agriculture and administered by the Forest Service. During the 3 years of the project, the efforts of many scientists were brought to bear on the problems involved. Research locations of the project ranged all the way from southwestern Texas across New Mexico, Arizona, and California, as far north as Salinas. Limited germplasm collections were made from wild stands both in the U.S and Mexico Thirty two thousand acres of guayule were planted and about 1,350 long tons of natural rubber produced. The project was quickly liquidated in 1946 when Congress failed to pass legislation to establish a guaranteed minimum price of guayule natural rubber for a period of 7 to 10 years, a time frame considered essential to facilitate production of guayule in the private sector With termination of that program in 1945, approximately 85 percent of the guayule shrubs established were not harvested, and an estimated 21,000,000 pounds of rubber were destroyed in the shrubs in the field. Although there was a low level of research on guayule continued in the Department until 1959, no further production of the shrub and harves of raw rubber was accomplished. Approximately 26,000 pounds of seed were on hand at the time the emergency program was terminated. This amount was considered to be greatly in excess of need for maintaining representative germplasm. The small samples retained were placed in long-term storage at the National Seed Storage Laboratory, Ft. Collins, Colorado.

The war emergency research effort on guayule and that which followed by the Department in a minimum way from 1947 to 1959 is summarized in USDA Technical Bulletin No 1327. Although this document is now out of print, a copy has been made for the use of the Committee.

In 1975, an International Conference on the Utilization of Guayule was held in Tucson Arizona. The opinion of plant scientists expressed at the Conference was that breeding, using a much wider base o germplasm, is essential as a first requisite for the successful commercial growing of guayule. It became apparent at the Conference that only the surface has been scratched in most areas relevant to guayule exploitation in breeding and genetics in extraction technology, in guayule rubber technology, and in understanding the value of by-products.

Increasing awareness of the ultimately limited supply of fossil fuel for chemical feedstocks and increasing U.S. dependence on foreign sources for materials suggested the need for serious reevaluation of the potential for agriculturally renewable resources including guayule.

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A National Academy of Sciences' study entitled "Guayule: An Alternative Source of Natural Rubber," partially supported by USDA, was published in March 1977. The study included a comprehensive review of available research data on guayule and recommends attention to a number of research needs. It concludes that:

> "The demand for all rubbers is expected to increase worldwide, and a market for guayule rubber is assured if it can be sold at a competitive price.
>
> "No difficulties are expected in manufacturing goods from guayule rubber; standard equipment can be used. It vulcanizes like hevea rubber, it has properties that allow it to flow properly in molds and extruders and, like hevea rubber, it has the natural tack crucial for tire manufacture.
>
> "There appears to be plenty of room for adding guayule rubber to the markets of the future, and it should not be considered as a displacement of hevea rubber. If, during the next decade, present growth rates continue, the world's demand for isoprene-type rubber is expected to almost double.
>
> "Because the guayule plant is native to a semiarid environment, it has relatively low water requirements. However, whether it can be economically cultivated in arid regions without irrigation is not yet clear, although the amount of irrigation water it needs annually is less than the requirement for most crops. Also the plant can be grown where the supply of rainfall or irrigation water is unreliable, as available moisture is used up, guayule enters a resting state and remains semidormant until moisture returns.
>
> "In the long run, as the Nation's petroleum disappears, guayule's greatest value may be as an alternative to the synthetic polyisoprene rubbers that are produced from petroleum. The guayule plant could become a renewable domestic source of polyisoprene rubber for the nation."

Since the National Academy report was published in March 1977, a growing concensus continues to develop among industry government and university research institutions, the National Science Foundation, and the National Academy of Sciences that the potential for development of guayule as a commercial source of domestic rubber is great enough to warrant significant efforts in its development. The technological needs of the program are becoming much more sharply defined. The critical need

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over the next several years will be a comprehensive and well coordinated effort among scientists and administrators in these institutions so that the most significant problems can be examined on the basis of their geographical and technical implications.

Current Activities

Awareness of the ultimately limited supply of fossil fuel for chemical foodstocks and increasing U.S. dependence on foreign sources for materials suggests the need for reevaluation of the potential of agriculturally renewable resources as supply for critical materials needs. With this motivation, experimental breeding plots and new collections of genetic materials have been initiated recently at the University of Arizona and the Los Angeles Arboretum. In Mexico and Israel, research projects are also underway.

The University of Arizona initiated a research program in March 1976 with seeds available from the National Seed Storage Laboratory. A germplasm collection study funded by a National Science Foundation (NSF) grant was conducted in August and September 1976, with seeds of guayule and three related species being collected from 45 locations in Mexico. Recently funding has been provided from the University of Arizona, New Mexico State University, and the Nevada Department of Commerce. One of the principal interests of the University of Arizona is to provide water efficient crops for use on land where water availability is becoming increasingly limited. Work has been initiated at the Los Angeles Arboretum under funding by NSF for genetic improvement of guayule.

Most recently a technology assessment has been proposed by the University of Arizona for NSF funding to examine the impact of technological, economic, social, and national factors and alternative actions open to government and the private sector regarding this new technology. NSF funding is also expected for cooperative research between the Los Angeles Arboretum and the USDA Science and Education Administration/Federal Research Fruit and Vegetable Chemistry Laboratory, where preliminary investigations with bioregulator chemicals have produced increased yields of rubber. This work would build on current USDA research. Preliminary laboratory results of this research indicated that a three-fold increase in rubber yield may be possible.

Recommendations Regarding H.R. 12559

This Department recommends that the bill not be enacted until the foundation for a program can be justified on the basis of a feasibility study.

If enacted, H.R. 12559 would authorize and direct the Secretary of Agriculture to initiate and carry out research, development, and demonstration projects leading to and culminating in the commercialization of natural rubber from the guayule plant. The Secretary would be further authorized

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to establish a bank of all pertinent research data on native latex, to enter into cooperative projects with the Government of Mexico, to accept financial or other assistance from any State or public agency as well as to make grants to educational institutions and scientific organizations. The bill would further provide an authorization of appropriations for the fiscal years beginning October 1, 1979, through 1983, in the amount of $60 million for carrying out this Act.

While the program outlined in H.R. 12559 is generally in keeping with most recommendations contained in the report of the National Academy of Sciences entitled "Guayule: An Alternative Source of National Rubber," H.R. 12559 does not accord entirely with the spirit of those recommendations. The report recommended a feasibility study, technology assessment, and environmental impact analysis of guayule. We believe these steps to be essential before recommending enactment of a program with a proposed authorization of appropriations of $60 million. Funding needed to undertake a program of Parthenium research, such as the one suggested in the National Academy of Sciences study, would be best established through the budget process, where the program's resource needs would be judged in competition with other research priorities.

We further suggest that the Department of Agriculture should serve a lead agency role in meeting the need for coordinated development effort. USDA is in a central position to effect this coordinated administration of programs. The Food and Agriculture Act of 1977 specifically identifies a need for new initiatives in the development of crop opportunities for income supplemental to major food production. Section 1414 of this Act also provides for a program of competitive grants. While the Congress intended maximum flexibility in selection of priorities for that competitive grants program, the conference report specifically states that priority attention should be given to the development of new crops including jojoba and guayule.

I might mention that another area that we think deserves exploration as a part of this feasibility study would be the potential for application of information gained from this kind of research and development to the field of hydrocarbon production--oil production from plants--which could conceivably benefit from the kind of research that is done in terms of guayule.

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Mr. DE LA GARZA. Thank you very much, Mr. Secretary.

I am satisfied with your recommendation, and I do not think that we are apart on that. You are not opposed to research and development.

I trust "of significant proportion" means that you are willing to cooperate to the extent necessary to make that possible?

Mr. UNGER. We do have the research and development of guayule as a major thrust being considered at this time in the development of our fiscal year 1980 budget. We do think it is important, and we are giving it every possible consideration at this time.

Mr. DE LA GARZA. That this bill not be enacted until the program is justified on the basis of the feasibility study, I do not know that I would quarrel with. Do you feel that the legislation could be enacted, providing for that contingency?

Mr. UNGER. Our statement does suggest that we feel it is more desirable to conduct feasibility studies as a part of the regular program of the Department of Agriculture and that it be a part of our ongoing program with research funds provided, if they can, in the budget for the Department and the Science and Education Administration, rather than through separate legislation at this time.

Mr. DE LA GARZA. Does the appropriate request now in the process for the Department of Agriculture include funds that could be utilized in research of guayule?

Mr. UNGER. The budget has not yet been prepared, and the process is just beginning.

As I indicated, we have it identified as one of those areas to which we want to give major consideration. It has to go through the zero-based budgeting procedure. It has to receive approval in the Department and in the administration. So I cannot say that we definitely will have a major effort in this area, but I am saying that we are giving it major consideration and have identified it as one of the priority thrusts that we want to consider in the development of that budget.

Mr. DE LA GARZA. Are there any funds now in the Department that you have committed to this?

Mr. UNGER. Yes—a very modest amount. I might ask Dr. Cowan to indicate what those funds are.

Mr. DE LA GARZA. Dr. Cowan, we welcome you.

STATEMENT OF ANDREW M. COWAN, STAFF SCIENTIST, BELTSVILLE SCIENCE AND EDUCATION ADMINISTRATION, U.S. DEPARTMENT OF AGRICULTURE

Mr. COWAN. I am Andrew Cowan. I am staff scientist for industrial use of agricultural products—a part of Federal research of USDA. I have responsibilities for review and evaluation of our programs in this area.

We have given considerable attention to guayule over the past couple of years, looking at its potential and the research that should be conducted.

We received an appropriation last year for guayule. In tailoring our research to that appropriation, we are conducting three small projects.

One of these is by Dr. Henry Yokoyama at the Pasadena Laboratory, the Fruit and Vegetable Chemistry Laboratory. Dr. Yokoyama has

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found chemical methods of stimulating the biological response of the plant to produce rubber.

In laboratory experiments, he has found that the rubber in the guayule plant—the young plant—is increased from twofold to sixfold. He has not yet had a close look at what this might do under field conditions but seems to be very much encouraged that stimulation of the production of rubber could be possible.

This is extremely important in that most of the economic analyses show that an increase in rubber yield per acre is important for the commercialization of the guayule rubber process.

If Dr. Yokoyama's results are proven in the field, it could be extremely important in leading to a viable economic enterprise.

Additionally, as a part of the appropriation for the current fiscal year, we are pursuing the need for providing information from the archives for investigators who need that information right now in other institutions where they are conducting research on genetic improvement of the plant. This information should become more readily available to them over the next several months.

In addition, we feel that it is important to acquire some samples of guayule, both in terms of the rubber that is produced in the Mexican pilot plant and also from the wild bush material itself, to confirm its extraction and its purification process and for testing purposes among various interested institutions so that we can have the best characterization of the rubber as possible.

Also, we have one other area of work that has been underway in the Department of Agriculture for about 3 years now. This work is located in Peoria, Ill., in our Northern Regional Research Center.

There, under the direction of Dr. Buchanan, an examination has been made of a wide range of rubber-bearing plants, looking not only at the rubber content but also the value of the various byproducts that would result from processing of those plants.

In doing so, the emphasis was to look on the total value of the plant as it might apply to a rubber production system.

In examining these plants, it is now apparent that guayule occupies a place very high on that list and that there does not seem to be other plants that could outyield or outproduce guayule and provide byproducts or coproducts that could be highly valuable and more economic at this time.

In addition, the work in that laboratory has also found a method for processing the guayule plant, providing for solvent extraction of the rubber and resin which may very much enhance the processing technology as it now exists.

We think that these developments, although they are very modest and on a small scale at this time, will lead to a better examination of the feasibility of an economic guayule production system in this country.

Mr. DE LA GARZA. Has either of you gentlemen visited the pilot program in Mexico?

Mr. UNGER. No, Mr. Chairman.

Mr. COWAN. No, sir. I was scheduled to be there last summer, but I was unable to make it. Dr. Quentin Jones, of our national program staff, did visit the pilot program and was able to discuss it with us in some detail.

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Mr. DE LA GARZA. It is my understanding that they are providing the raw material for that plant solely from wild bushes. There are no grown tracts of bushes. I do not know if that is correct or not.

Mr. COWAN. That is my understanding as well. They are harvesting the wild stands. They have not begun extensive cultivation of the guayule at this stage.

Mr. DE LA GARZA. There is a plant, and we have seen the rubber at the other end.

My concern, Mr. Unger, is with your comment that we wait until the feasibility study is complete. That was my question. Could we not enact some legislation with some sort of contingency providing for—I guess what we are looking for from your end is the ultimate assurance that it will work. We know it works, so we are looking at the economics.

I do not know that we want to go into a crop for which it will be necessary to come back here for a subsidy of some kind.

Is this what you are talking about?

Mr. UNGER. I think our major point is that a program with the proportions as proposed in this legislation, we feel, should not go forth without some additional study of the feasibility, the economics of potential commercial production, and that a $60 million program is a substantial investment to make without additional research and development work.

Mr. DE LA GARZA. You should see some of the things that are done here for much more than $60 million.

To what extent are you acquainted with the National Science Foundation's study?

Mr. UNGER. I have reviewed it, and of course our statement summarizes it. Personally, I am not that familiar with it. Dr. Cowan is more familiar with it.

Mr. DE LA GARZA. What more can be added to that study, Dr. Cowan?

Mr. COWAN. I think that the study points up some areas of uncertainty that need to be examined. One of these has to do with the water requirements of the plant.

The study points out that for economic rubber production it is likely that the areas in which guayule is native will require some irrigation water. The amount and extent of its availability is not clearly known at this time.

I think this is typical of other uncertainties that might exist. I think these need to be clarified—the specific areas adaptable to the production of guayule and the amount of area required will need to be examined in the feasibility study.

Mr. DE LA GARZA. But it grows in the arid, no-rain areas quite prolifically. Do you think more study should be made into how much water is needed?

Mr. COWAN. The wild stands require much longer to produce a quantity of rubber than a cultivated, farmed, and irrigated approach to the growing of guayule.

Mr. DE LA GARZA. The Commerce Department has provided some funding to a guayule program in the Southwest. Are you acquainted with that?

Mr. COWAN. Yes, sir.

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Mr. DE LA GARZA. Have you worked or coordinated with them, or is it separate and apart?

Mr. COWAN. Dr. Quentin Jones and I have been a part of the oversight committee that examined the research proposal.

Mr. DE LA GARZA. They provided $60,000?

Mr. COWAN. I was thinking it was on the order of $100,000.

Mr. DE LA GARZA. $100,000?

Mr. COWAN. Yes; I am sure that others here today can testify to that. Dr. David Rubis, of the University of Arizona, is the principal investigator, as I understand.

Mr. DE LA GARZA. What is the title of the border commission?

Mr. COWAN. It is the Four-Corners Commission.

Mr. DE LA GARZA. They have provided some funds, either to the universities or to A. & M. of Arizona.

Mr. COWAN. It is to the University of Arizona, New Mexico State University, and an agency in Nevada.

Mr. DE LA GARZA. Texas A. & M. is supposed to share in part of that research that is being done around or near El Paso. Mr. Brown?

Mr. BROWN. Mr. Unger, I have had a chance to review your statement rapidly. It does present a fair picture of the development of guayule and some of the problems involved.

Unfortunately, it comes to the conclusion that you do not need this legislation and the natural processes in the Department of Agriculture will result in the elevation of this program to the necessary priority and whatever action is desirable.

That was what I was told 15 years ago when I went to the Department to see if they would be interested in a guayule program.

Obviously, you are going to say that many things have changed in the last 15 years, but the fundamental things have not changed in the slightest. The reliance of this country on imported oil and the need for an indigenous natural supply of resources are the same now as they were 15 years ago.

The economics change slightly, depending on what the highly manipulated markets in oil do, and other things change, but the basic situation has not changed.

Now, how can I feel assurance that you are going to elevate this to the priority consonant with what this legislation would provide? I am not saying this in any way as a reflection on you. I assume you have not been in the Department for 15 years. I may be mistaken.

Mr. UNGER. That is correct.

All I can say is to indicate that I do believe there are some things that are changing. The recognition of the importance of this is higher than it was. The fact that the national conference was held, the fact that the National Academy report was prepared, indicates a renewed interest, I am sure, due to much attention on the subject by you and others who have supported this work over the years.

There is the fact that we have a small appropriation for this in our current fiscal year budget, and we have resumed some research in this area. This indicates that we are responding to this further and that there is expanded interest.

Of course, we also have direction from the Congress in the Food and Agriculture Act, indicating the strong desire of the Congress to see additional priority given to this.

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Mr. BROWN. May I interrupt you at that point?

Mr. UNGER. Yes.

Mr. BROWN. Did the Department ask for funding under that section on new crops?

Mr. UNGER. In fiscal year 1978?

Mr. BROWN. 1979 or 1978. The act was only just passed which would not allow you much time to get geared up in 1978.

Mr. UNGER. There is no specific request for new crop funding.

Mr. BROWN. That is the problem I have with your statement, Mr. Unger.

Mr. UNGER. Well, no matter what has happened in the request for fiscal year 1979, I do know that this is identified as a major thrust for consideration in fiscal year 1980 negotiations that are going on right now.

Mr. BROWN. I am pleased to hear this. I accept it in good faith. But I do not accept the fact that possibly your motivation to continue to examine this with a high priority might not be increased a little if the Congress indicated its interest by the passage of this legislation. Is that a reasonable point to make?

Mr. UNGER. Certainly the Department of Agriculture is very interested in direction given by the Congress.

Mr. BROWN. It seems to me and many others who have examined this thing that while we do need some additional research, all of agriculture needs additional research and probably will always continue to need it.

What we need is to plant about 50,000 acres of guayule and get the practical experience in the economics of it, the processing problems—we have not developed full-scale processing plants. We do not know how to dispose of the residues and gases and resins and so on. We do not know the marketability of them, and we are not going to find out until we plant the guayule, build the plants, and gain some practical experience.

What we need is a full-scale demonstration, not a continuation of $50,000 research projects by very qualified people around the country who are very interested, but we are ready to move, it seems to me, to the stage to which we should have moved 15 years ago.

That is sort of rhetorical, is it not?

Mr. UNGER. It is very well stated.

Mr. BROWN. That is all the questions I have, Mr. Chairman.

Mr. DE LA GARZA. Dr. Cowan, where are you in the research now? What else do you need to do besides the water study—on the research, on the plant, and on the growing of the bush, and so on? Where are you now?

Mr. COWAN. I think that as the National Academy report indicated the area of genetic development of the plant, the area of agronomic practices utilizing modern techniques, and the process technology all have just barely scratched the surface in determining the potential of guayule.

I think each of these areas needs to be explored in further detail.

Mr. DE LA GARZA. You are talking like a very conservative scientist. We know what the potential of guayule is. We ain't got no natural rubber, and that thing makes rubber.

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In Agriculture, you are the one closest to the research, are you not? Are you the guayule man in the Department of Agriculture in research?

Mr. COWAN. I work very closely with our scientists who are involved in it.

Mr. DE LA GARZA. Now, will you need 3 months, 6 months, or 6 years? Timewise, where do you think we are?

Mr. COWAN. In terms of the research phase or early feasibility stage, I think we are in a period of about 3 to 4 years of research before extensive demonstration plantation and processing should be planned and undertaken.

Mr. DE LA GARZA. With regard to this last appropriation, apparently you asked for the same amount—$53,000 for whatever—and we added $15,000 more. That does not hire an assistant to a scientist. Certainly, you would not hire a scientist or add very much more to the work by adding $15,000 more. Part of it may be our problem here. We should have just provided for more. What criteria do you use for the 3 or 4 year period?

Mr. COWAN. I look at it in terms of the time that it takes to do the genetics research. I was not talking about that effort being solely of the Department of Agriculture but of various scientists in various institutions that are now working on it.

Mr. DE LA GARZA. I understand that, and there will be other people testifying to that. I wanted to get from you, as far as the Department is concerned, some semblance of time, knowing what you know now and what you are looking at and what you think you would like to look at.

Mr. COWAN. The 3- to 4-year period I have mentioned, I think, depends strongly on the time that it takes to do the genetics research, the agronomics research, and the process development research necessary in order to properly design a processing plant and a plantation system and go on for a large-scale demonstration.

I think that our experience in past work indicates this is the sort of effort and time that is necessary.

Mr. DE LA GARZA. Thank you very much.

Mr. Secretary, you say that the process now for the next appropriation request of the Department of Agriculture looks for a substantial investment by USDA into the research of guayule. Was that your testimony?

Mr. UNGER. What we have done is to identify a number of major priorities, or what we call "thrust areas," that we are considering within the Department at this time in the design of the budget for the science and education administration for fiscal year 1980.

We have identified guayule and jojoba and new crop development as one of those thrust areas and are considering what we could propose as an adequate level of funding for research under the circumstances that Dr. Cowan has described here for fiscal year 1980.

This has to go through the budgetary process, as I indicated. It has to be proven against these other thrust areas and other priorities. But I can assure you that it is getting substantial attention at the present time in the budget development process.

Mr. BROWN. Mr. Unger, have you reviewed the legislation which is the basis for these hearings?

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Mr. UNGER. Yes.

Mr. BROWN. Is there anything which the legislation directs the Department to do that you would not be doing under any circumstances as part of your development program on guayule?

Mr. UNGER. I would have to reread it to determine exactly whether that is the case. I am sure that the largest share of the things in this legislation constitutes the kind of programs that we can and should carry out.

Dr. Cowan, would you want to comment on that?

Mr. COWAN. It is my view that there is no major element of the program that is missing from the legislation. I think it is comprehensive and does cover the essential steps that are needed.

Mr. UNGER. I think that our statement indicates our concern and sympathy in terms of the development of this crop. Our problem is in terms of this large investment without going forward with additional feasibility studies, as was indicated in this very comprehensive report the National Academy prepared.

Mr. BROWN. The Congress is aware of this problem and the fact that the administration does not like to have its budgetary hands tied by legislation, but this is done in the most flexible as possible way.

It sets forth $60 million for 5 years without even setting the annual levels, all of the money to remain available until expended. That is assuming that the Appropriations Committee would provide that amount, which is dubious, but they might provide part of it.

In other words, what we have here is a program which leaves you almost complete flexibility but a framework that establishes a high priority for this program.

I am not quite able to see how this is restrictive on your operation.

Mr. UNGER. In terms of the constraints that the administration is trying to keep on new authorizations for funds, in terms of the attempt to keep the rate of inflation to the lowest possible level—I think it is on those kinds of terms that we take the position we do. We need to be very careful before authorizing a program of this magnitude without some additional information.

Mr. BROWN. We are certainly aware of the administration's concern with regard to inflation. May I assure you that Congress shares it.

We have felt that one of the best ways to control inflation was to avoid sending billions of American dollars overseas for some of the things we can produce in this country.

Mr. DE LA GARZA. Mr. Grassley?

Mr. GRASSLEY. I have no questions, Mr. Chairman.

Mr. DE LA GARZA. Mr. Cowan, do you have a written statement?

Mr. COWAN. No, sir. I do not have a prepared statement.

I would be happy to amplify on some of the questions you have asked with additional material, if it would be useful.

Mr. DE LA GARZA. We appreciate your being here.

If you feel that you can contribute more from the science aspect of it, we will be happy to receive it from you at a later date.

We thank both of you gentlemen for being here.

Mr. COWAN. Thank you.

Mr. UNGER. Thank you.

Mr. DE LA GARZA. Our next witness is Dr. Neville Clarke, director of the Texas A. & M. experiment station.

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We welcome you and your able assistant, Mr. Daniel M. Bragg. We appreciate your bringing some of the products that we are discussing today.

Mr. CLARKE. I did not realize when we brought the plants up here that you had spent as much time studying them, yourself, under field conditions as you have. We did bring along one of the plants that come from the native stands.

The one on the left comes from the Fort Stockton area and is a fairly old plant. You can get some idea of the root structure. Because of recent rains in our area, the plant is in the flowering stage. It was pulled up, I believe, about 3 days ago.

The one in the pot, here, was planted in January of this year. It has been under greenhouse conditions at College Station during that time.

We hope this will give some of the members and staff an idea of what is going on in Texas on guayule, if you have not already seen it.

Mr. DE LA GARZA. Without objection, your full statement will appear in the record at this point.

[The prepared statement and attachments thereto submitted by Mr. Clarke follow:]

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STATEMENT OF

NEVILLE P. CLARKE
DIRECTOR

THE TEXAS AGRICULTURAL EXPERIMENT STATION
TEXAS A&M UNIVERSITY

Mr. Chairman, Members of the committees. My name is Neville P. Clarke. I am the Director of The Texas Agricultural Experiment Station which is a part of The Texas A&M University System. With me today is Daniel M. Bragg, an Associate Research Engineer in the Industrial Economics Research Division of the Texas Engineering Experiment Station, which is also a part of The Texas A&M University System. Mr. Bragg is the principal investigator of a grant proposal to the National Science Foundation entitled "Feasibility of Producing Natural Rubber from Guayule Plant," which is a joint research effort to be conducted by The Texas Agricultural Experiment Station and the Texas Engineering Experiment Station. I will refer to this proposal in my remarks and Mr. Bragg will be available to answer any questions you might have regarding his work.

Mr. Chairman, I appreciate this opportunity to testify before the two subcommittees about H. R. 12559. In this testimony, we will deal with the following topics:

1. Economic overview of the possibilities of using guayule as a source of natural rubber.

2. The total production system approach to guayule production.

3. Short versus long-term research and demonstration on the agricultural aspects of total production.

4. Need for sustained research activity.

5. Alternative federal agency support.

6. Review of history and current research.

Mr. Chairman, I will begin by saying that my colleagues in agricultural research in Texas and other southwestern states believe there is considerable

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room for optimism for the potential development of guayule into a commercially and economically feasible crop for the production of substantial quantities of natural rubber. However, in my opinion, we should dispel at the outset any concepts of simply going to the desert to harvest existing stands of natural plants to make quantities of natural rubber that can contribute significantly to projected shortfalls of this resource. If guayule is to become a viable crop for natural rubber production, we believe that a total systems approach to production must be validated through research and demonstration. We basically endorse the conclusions and recommendations of the recent National Academy of Sciences report "Guayule: An Alternative Source for Natural Rubber." While there are obviously many uncertainties at the present time, one can at least speculate about the possibilities of guayule providing an economically attractive alternative for rubber production by some general considerations.

The nation is totally dependent upon foreign sources of natural rubber and, due to importation of oil, dependent on others for almost one-half of the synthetic rubber we use. The strategic importance of rubber is almost immeasurable and world demand for all types, including natural rubber, is expected to double in the next 10-25 years. But the production of HEVEA, our only other source of natural rubber, cannot keep pace with demand. Thus, most forecasters estimate there will be a shortfall of this material, ranging from one to two million tons per year by 1985. Since U. S. consumption of HEVEA is almost a million tons per year today, and our source of rubber continues to grow more unreliable, it would appear that development of economically viable alternatives is of immediate importance.

Based on the average rubber content of the varieties of guayule now available, about ten percent, it is estimated that as many as eight million acres would need to be placed in cultivation to meet projected yearly demands.

It seems clear that the long-term beneficial solution to rubber production on a domestic basis must be founded on a sound economical system. There will most likely have to be some type of assistance provided to farmers initially, but over

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the long haul, production must be based on a beneficial profit to growers. Guayule must offer an advantage over HEVEA to the rubber industry in terms of price, availability or some other attribute.

Although natural rubber prices have always closely tracked those of synthetics, the rising cost of raw materials (oil) could possibly price synthetic rubber off the market in the foreseeable future, if lower-priced substitutes can be found. As the price of synthetic rubber rises, HEVEA will likely continue to follow, until the danger of over-pricing makes itself felt. At that point, HEVEA growers will attempt to hold down any further increases, but as a result of past price inflation, labor and overhead costs may be so high as to prevent price stabilization.

Since guayule production lends itself to mechanization, in contrast to the labor-intensive process required for HEVEA, guayule growers should be better able to maintain the market price of their product at fairly stable levels, with increases in rubber yields offsetting any increases in cost.

In respect to traditional crops, guayule appears to offer a number of advantages, the most apparent of which is its low water requirement. Although other factors are important in the production cost equation, the steadily rising price of energy is rapidly making irrigation water the largest of all costs in many growing regions. Under these conditions, guayule agriculture could become a boon to vast areas of our arid and semiarid Southwest, and could bring significant relief to the chronically depressed economics of this region.

Because guayule has not been produced on a large scale since World War II, data on production systems and associated socioeconomic implications have become outdated. The available information from the Emergency Rubber Project of 1942-46 is only partly of value since production and harvesting techniques--as well as goals and priorities--have changed considerably. Thus, there is an urgent need to develop new production, harvesting, and extraction systems if guayule is to become a viable agricultural crop capable of filling all or a part of the U.S. need for natural rubber.

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The systems approach to guayule production research includes a substantial effort in agriculture. In the short run, we would propose research and demonstration that evaluates the economic and industrial practicality of using existing germplasm and near term cultural practices to produce yields of guayule rubber which are economically attractive. We do not propose to research the problem to death before we discover whether or not it will work. However, there is a very substantial experience from development of other crops, such as sorghum and cotton, in our state to show that major improvement in economic yield can be achieved through long-term research on development of improved germplasm and management practices. For instance, in the same Trans Pecos region of Texas where the potential for guayule production exists, we have recently demonstrated a reduction in production costs of cotton from 70 to 40 cents per pound through introduction of new varieties of short season cotton used in conjunction with improved integrated crop management schemes. We speculate that through similar research we can expect to increase basic yields of guayule by not less than a factor of two over a five to ten year period. Thus, we propose that interim economically feasible production alternatives be explored immediately and that concurrent long range research be initiated to provide follow-on improvement.

Short-range Research:

1. Determine economic feasibility of guayule production.

2. Define nature and extent of native stands of guayule.

3. Improve propagation methods, including cloning.

4. Evaluate cultivated stands of native and previously selected guayule.

5. Develop short-term cultivation and management practices.

6. Improve methods for assessing rubber content and quality.

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7. Improve extraction under factory conditions, including construction of pilot plant facilities.

8. Identify policy issues related to establishing a viable commercial guayule industry in the United States.

Long-range Research:

1. Develop improved germplasm for improved performance.

2. Improve cultural practices.

3. Develop a program of integrated crop management (including pest management).

4. Study the physiology and biochemistry of rubber formation in the guayule plant.

5. Develop mechanized methods for guayule production from the nursery to the factory.

6. Evaluate potential socioeconomic and environmental impacts of a large-scale guayule production system.

Expertise exists today for initiating a guayule research program. It resides not only in the federal sector, but also in the universities and private industry. In Texas, as in the other southwestern states, this talent is held both by active and retired scientists who participated in earlier guayule research, as well as by other qualified researchers in a number of disciplines and institutions. For example, the head of the Plant Sciences Department at Texas A&M University was an

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active participant in the Emergency Rubber Project of World War II, while one member of his current faculty worked on the Natural Rubber Extraction and Processing Investigations of the fifties. Their existing levels of familiarity with the guayule plant will make these individuals invaluable as resource persons during initiation of a new research program. To provide the Committees additional detailed information, we are including as appendices to this testimony summaries of the history of guayule production research in Texas and some notes on current research programs in the southwestern part of the United States.

It seems clear that federal funding will at least initially be required to successfully launch a meaningful program of research on guayule. Several federal agencies have either real or potential interest in this opportunity. The agricultural research needs would appear to fall under the general mission of the USDA. However, we would be concerned that this non-food new crop would fare poorly in their assessment of national priorities in the near term. The National Science Foundation has expressed interest in the basic science aspects of the program, and we would hope that this important aspect could be supported, at least in part, through that agency. The total production system requires industrial development which may fall in an area of mutual interest between USDA and the Department of Commerce. The Department of Commerce has a focal point of current interest in one of its regional commissions, and some funds are currently being made available to border states for guayule development through this means. It may be that these agencies have, in fact, sufficient authorization to proceed in a limited manner with this area of research. However, we believe that this new legislation will be necessary to focus attention on the opportunity and to offer a reasonable chance of success in the appropriations process.

We can profit from history in recognizing that successful development of guayule as a source of natural rubber requires sustained research and development over a protracted period. Previous programs were stopped short of major payoff when the emergency generating them was abated. The National Academy report and

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the USDA view (expressed in Mr. Bergland's letter to Senator Randolph on March 15, 1978) favor a feasibility study, technology assessment, and environmental impact analysis of guayule prior to making a major commitment of resources to the total program. We have suggested in a similar vein that short- and long-range research be undertaken. We believe, however, that the onger range and more basic starts should not be delayed while current materials and methods are evaluated. These long-range efforts would not be excessively costly n their inception and could be terminated should short-term work show a definite reason to stop. Long-term work could very well suggest through preliminary results approaches which would offer solutions to main problems discovered in short-term studies. We could avoid the several years of delay of long-range payoff by a simultaneous attack on both short- and long-range objectives.

A word about state and federal participation. As stated above, there is substantial capability from both sides to contribute to this program. Several of the southwestern border states have already established foci of interest and growing scientific capability. We would urge the Committees to insure in this legislation that full advantage be taken of this interest and capability in the States and that the magic of the Agricultural Experiment Stations approach to regional research be used in this important new area of research and development.

The Texas Agricultural Experiment Station not only has a history of involvement with guayule, but is presently actively engaged in guayule research. It might be noted that the organizational meeting for the guayule seed stockpiling program of 950 was held at Texas A&M in December 1949. Today, four separate investigations of guayule are either in progress or under active planning. One of these, a demonstration project to develop cultural practices at Pecos and El Paso, is currently under way through funding from the Southwest Border States Regional Commission, a Departmen of Commerce Title V organ zation. Three others--one, an evaluation of guayule's market potential and cost to produce; another, an inventory of native stands of guayule in Texas; and the third, a laboratory-scale study of rubber extraction processes--are all in various states of preparation for funding consideration by the National Science Foundation.

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In summary, we believe that the opportunity of developing the guayule plant as an economic source of natural rubber should be explored at the earliest possible time. We believe that the states where production is possible should be supported with new research funds. We are convinced that new enabling legislation will be required to provide the focus of attention and priority needed to provide authorization of these funds.

Mr. Chairman and members of the Subcommittees, thank you again for inviting us to present this testimony.

(The attachments follow.)

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Appendix I

HISTORY OF GUAYULE IN TEXAS

Texas has the distinction of being the site of the original discovery of guayule, so far as science is concerned. The discovery was made by a physician, Dr. J. M. Bigelow, in 1852 while attached to the Mexican Boundary Survey. Some years later the plant was described by Professor Asa Gray of Harvard in his "Botany of the Boundary" and given the name Parthenium argentatum.

The plant grows in only a relatively small area in the Big Bend section of the State, but extends southward over a large territory on the Central Mexican Plateau.

Following its discovery, sporadic attempts were made to develop a commercial guayule rubber industry, but it was not until the invention of a suitable mechanical extraction process early in this century that the idea became feasible. American capital began the construction of processing facilities in Mexico, and from about 1904 to 1946 there was a steady flow of guayule rubber from the factories. The United States utilized most of the production.

A mill was built at Marathon, Texas in 1909, using the readily available shrub. It ran for less than a year and then shut down. It was not dismantled, however, and in 1925 was reopened and ran for about a year and a half. It was finally dismantled in September, 1926.

Shortly after beginning operations in Mexico, the principal producer there, the Continental-Mexican Rubber Company, began investigations into the domestication and culture of guayule. A botanist, Dr. W. B. McCallum, was employed and began his research work on the Company's properties in Mexico. Because of the outbreak of the Mexican Revolution, he shortly afterward moved to California and carried on his investigations. Among other research lines, he attempted to delimit the areas in the United States adapted to guayule culture and established a number of test plots in Southwestern Texas, as well as California, Arizona, and New Mexico.

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Because of the wide differences in climate, physiography, and soils, and to facilitate the survey work of the Emergency Rubber Project, Texas was divided into six regions designated as follows: (1) Rio Grande Plains, (2) Trans-Pecos, (3) Edwards Plateau, (4) Plains, (5) East Texas, and (6) North Central.

Far eastern Texas, or approximately that part east of the ninety-seventh meridian, was not included in the report since most of this area was definitely unsuitable for guayule because of excessive rainfall.

When the Japanese invaded southeast Asia, the United States lost most of its rubber supply. As a consequence, the Emergency Rubber Project was developed and massive efforts occurred to initiate guayule rubber production in the United States. These efforts were made with some of the best scientists available and were a cooperative effort between the United States Forest Service and Department of Agriculture. The Forest Service conducted the production and the Department of Agriculture did the research. Those efforts were curtailed four years later, and roughly 32,000 acres of guayule were burned or plowed under. The Forest Service's summary of the efforts during that emergency goes on to describe many of the scientific details regarding the massive efforts conducted by the large team that was put together to produce native latex rubber. Those efforts were due to the truly "emergency" requirements during the war years. The researchers did make significant progress. Their patriotism and dedication in time of national emergency is to be admired.

When the Korean conflict began, the United States Department of Agriculture again put forth efforts to initiate domestic rubber production and this resulted in the production of about 500 acres of nursery stock to be transplanted into about 10,000 acres of production. Once again, after the crisis subsided the program was discontinued and the plants were plowed under just at the transplanting stage.

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Appendix II

CURRENT RESEARCH AND DEVELOPMENT

Institutional - Currently, research on guayule is being conducted at the Los Angeles County Arboretum and at other locations in California by Dr. George P. Hanson with the assistance of the National Science Foundation. The California research has been in progress for about three years and includes efforts on germination, seed cleaning, cloning, nursery production, field transplanting, and rubber analysis.

In Arizona, Dr. David D. Rubis coordinates the Four Corners Commission sponsored research which is not only being done at different locations in Arizona, but also in New Mexico and Nevada. Their efforts for the last two years center principally on production of seed, genetics, new selections of plants from Mexico and weed control.

In New Mexico, Dr. J. Wayne Whitworth, a weed specialist with the USDA rubber project of 1951, is directing their efforts.

In Texas, Dr. Jimmy Tipton at the Texas Agricultural Experiment Station at El Paso is just initiating research with support from the Southwest Border States Commission. At El Paso, seedlings are just about to be transplanted from the nursery to the field.

All of the above scientists are cooperating and exchanging information as it becomes available. They all are initiating plantings of a uniform variety testing nature to determine and reevaluate adaptability of various selections.

At College Station, Dr. Charles S. Miller of the Plant Sciences Department is assisting in the coordination of guayule research and has a very small planting in the greenhouse and in the field. Dr. Miller was a scientific aide for the USDA rubber project in 1951.

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Industrial - According to Dr. David D. Rubis, Firestone is going to begin research efforts at its test track site near Ft. Stockton, Texas in the near future. Other companies, including Goodrich and Goodyear, are definitely interested in expanded research efforts on guayule.

Many of the problems associated with the development of guayule remain the same as those faced during the Emergency Rubber Program days of the 1940's.

Seed Source - The development of even experimental sized plantings of guayule is currently limited by the availability of seed. Researchers must be content to start with about fifty seeds each of the older selections. These can be requested from the National Seed Storage Laboratory at Ft. Collins, Colorado. The situation is being changed slightly and should improve in the future due principally to the efforts of Dr. David D. Rubis at Arizona and Dr. George P. Hanson at the L. A. County Arboretum. These efforts should be expanded as much as possible with the few people involved. One of the principal problems is seed cleaning. Currently this is a laborious, tedious process.

Cultural Practices - Progress has been made through modern technology over the cultural practices used by the Forest Service to initiate production in the 1940's. Currently, seedlings are grown in flats in the greenhouse and transplanted into the field at about one month of age. Even under present conditions this is not very easy.

Some of the original concepts have been to plant guayule on arid lands. It is, however, not possible just to seed desert land and stand back and in four years harvest the shrub for rubber. The only feasible solution is either through production of seedlings for transplant into arid lands through intensive greenhouse production or through establishment of field nurseries under irrigation and transplanting. At the time of transplanting, irrigation will be needed to insure adequate plant establishment. Without adequate water, many years would be required for production.

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Weed and Insect Control Problems - In establishing a direct seeded field nursery, the seed must not be planted more than one fourth inch deep, and the seed must be kept moist. The plants will emerge (if they have been properly treated) in about ten days, but they can not successfully compete with native weeds. Herbicidal oils were used in 1951, but until now the newer herbicides have not been tested. Once the proper herbicide and rate have been determined, there exists another problem. The present herbicides are not registered with EPA for use on guayule. Initially, the acreage will not be sufficient to enable the agricultural chemical companies to do the work needed for label registration, thus, it will have to be done by public agency support. Growers spend more for herbicides and weed control than for any other agronomic practice.

There are several insects known to attack guayule. These include army worms, aphids, red spiders, and many others. The young seedlings are especially vulnerable to insect attack. In 1951, several acres of nursery were lost in three days due to insects. There have been no attempts to use the modern concepts of integrated pest management on guayule. A need exists in the early development of guayule for a combination of an ecological and insecticidal research to determine the most economical methods of insect control. Again, there is no insecticide registered for use on guayulė. This time-consuming and expensive necessity must be done with public agency support.

Adaptation - Guayule is native to Mexico and parts of Texas. It normally grows on rocky, calcareous slopes of mesas at an altitude above 2,000 feet. The only native stands of guayule are believed to be in the Big Bend area and around Ft. Stockton, however, the last survey was conducted in the 1940's, and it is not known how much change has occurred since then. A plant that will cross with guayule is known to grow further north into Arizona. Part of the basic program of the University of Arizóna is breeding plants that will be more cold resistant. This may be possible through the crossing of guayule with mariola and selecting the higher rubber producing plants that are cold tolerant.

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Guayule presently can be grown only in four southwestern states (i.e., California, Arizona, New Mexico, and Texas). One or more areas in these states will eventually become the production sites due to climate and soil. Texas has areas potentially well suited to guayule production. For example, in the Pecos area it has become too expensive to irrigate because of increased fuel costs. This area does, however, have the wells and possibly could afford irrigation for nursery production and then transplant and sustain production with only occasional watering as trickle irrigation.

Genetics - Initial genetic research has been done by the L. A. County Arboretum and the University of Arizona. Efforts include the selection of new material from Mexico. Plantings have been made to determine the adaptability of new selections, as well as the 25 selections available through the National Seed Storage Laboratory. To our knowledge, no crosses have been made. Rubber analyses have been initiated on the California plantings, but not on the Arizona, New Mexico, and Texas plantings. Breeding efforts should be expanded into Texas and include a geneticist-breeder at one of the future production sites.

Before commercial production is feasible, it is essential to determine which of the selections would be suited for each area. Presently, researchers cannot make a reliable prediction of the proper selection of guayule for any given area. The plants simply have not been grown in enough locations for sufficient time. In addition, when a search of the archives has been completed, identification of suitable selections for specific locations may occur.

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NEVILLE P. CLARKE

Dr. Neville P. Clarke was appointed Director of the Texas Agricultural Experiment Station by the Board of Regents, The Texas A&M University System on December 1, 1977. He had served as Acting Director of this organization since August 1, 1977. Clarke was previously Associate Dean for Research and Professor of Physiology at the College of Veterinary Medicine, Texas A&M University. He has been consultant to the Air Force Surgeon General on Biotechnology Research and Development and is a member of the Aerospace Medical Panel of the Advisory Group for Aerospace Research and Development of NATO. In 1976, Clarke was appointed to the Executive Council of the National Academy of Sciences National Research Council Committee on Hearing, Bioacoustics and Biomechanics. In 1977, he was appointed a member of the USAF Scientific Advisory Board. He is author or co-author of 57 publications in scientific journals and numerous abstracts in the area of physiological effects of vibration and stress on man and animals. He held three key management positions in the Headquarters of the Aerospace Medical Division. Dr. Clarke was responsible for formulating the first effective five year research and development plan for all the biomedical research in the Air Force. He was subsequently instrumental in developing similar plans at the Department of Defense level. As Director of Research and Development, Headquarters, Aerospace Medical Division, Dr. Clarke was responsible to the Commander for formulating, advocating and managing all of the biomedical research and development conducted by the Air Force.

EDUCATION:

Doctor of Philosophy (Physiology), School of Medicine, University of Washington, Seattle, Washington 1967

Training Program in Cardiovascular Research Techniques (R. F. Rushmer, Director), University of Washington, Seattle, Washington 1960

Master of Science (Physiology), School of Medicine, University of Washington, Seattle, Washington 1960

Doctor of Veterinary Medicine, A and M College of Texas, 1954

Associate of Arts (Pre. Med.), Southwest Texas Junior College, Uvalde, Texas 1949

MILITARY SERVICE:

United States Air Force Veterinary Corps, Retired Colonel, 1975

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Mr. CLARKE. You might notice that the plant we have brought from College Station that has been under greenhouse conditions has grown rather rapidly under carefully developed cultural practices. As was stated in earlier testimony, we believe that under this kind of cultivation system we can probably increase the yield considerably over what you get from the natural plants in the desert grown with limited water.

It is not yet known how exactly one should go about stressing the plant to maximize the rubber production between the application of irrigation and drought stress.

Mr. DE LA GARZA. Thank you Mr. Clarke. Mr. Brown?

Mr. BROWN. Dr. Clarke, you have indicated the desirability of making this a cooperative project with the States to take advantage of the expertise which exists in the regional agricultural experiment stations.

My question is directed at our relationship with Mexico which has had, I think, a more sustained interest in this possibility of rubber from this plant than the United States.

Do you consider that it would be reasonable and feasible for this to be a program in which we could jointly engage in research in this area with Mexico?

Mr. CLARKE. Yes, sir, I do.

There have been a number of meetings held jointly between the people of the Southwestern States and the people involved in the Saltillo production plant. We believe that this relationship should be continued.

We believe it would be particularly helpful to us in the early phases of getting started to take advantage of the expertise that has been developed there and to have access to some of their raw materials.

Mr. BROWN. Both countries, then, could benefit from a coordinated approach?

Mr. CLARKE. Yes, sir.

Mr. BROWN. You are familiar with the fact that the Indians of the Southwest have expressed a considerable interest in this from the standpoint of providing an additional indigenous both agricultural activity and possibly future industrial activity.

Have you given thought to the potential significance of this development as a means of solving some of the hardcore unemployment problems which are quite serious on all of the reservations that I know about?

Mr. CLARKE. Yes, sir.

I think there are two considerations that need to be brought into focus on that point. The first is the one that you have made. The potential for the small producer to operate, particularly in the semiarid regions of the Southwest, is real and can be a contributing part of the total solution to the projected shortfalls of natural rubber in the 1980's.

I believe, on the other hand, that it is probable that we will need to employ the modern techniques available to large-scale production agriculture in at least a part of this total activity in order to really get at the shortfall.

I mentioned in my testimony that this might well turn out to be a situation in which the economically feasible way of approaching it is to make guayule a part of an overall multiple production system

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where sharing of equipment between crops grown in semiarid areas and crops grown in adjacent irrigated areas might turn out to be more economical.

Mr. BROWN. Thank you. I have no further questions.

Mr. DE LA GARZA. Mr. Grassley?

Mr. GRASSLEY. Mr. Chairman, I do not have any questions.

Mr. DE LA GARZA. You mentioned, either in your statement or in the history of guayule attached to your statement, Dr. Clarke, the availability of seeds.

Is there sufficient seed available now to conduct the necessary research and plantings that might be needed?

Mr. CLARKE. This is a very important problem that we have in the short range, Mr. Chairman.

We had very little of the germplasm that was a part of the improvement program of the 1940's and 1950's that was retained for use later on. This has been stored at the seed repository in Fort Collins. At the moment, individual institutions are only able to get something on the order of 50 of these seeds for the different varieties of initial developments towards improved varieties of guayule.

So, there is a shortfall there which is being addressed by researchers in Arizona and California. We are beginning to acquire some additional natural stand seeds in west Texas.

One of the encouraging aspects of the seed and germplasm story is that there does seem to be a very substantial variability in the germplasm in terms of rubber production, and we believe that this variability gives us a very good chance, through genetic manipulation, to increase the overall productivity of the plants.

Mr. DE LA GARZA. Dr. Cowan, does USDA have its own supply or are you limited by this?

Mr. COWAN. The laboratory at Fort Collins is under USDA, so that is the supply.

Mr. DE LA GARZA. Dr. Clarke or Dr. Cowan if you can help out, timewise, what are we talking about to have the necessary amount of germplasm or seed?

Mr. CLARKE. Mr. Chairman, we believe that that is primarily related to the funding level that is provided for our research in the next few years.

If we assume reasonably adequate funding, certainly it would be adequate in terms of the authorization you propose in this legislation——

Mr. DE LA GARZA. Funding would have a direct bearing on how fast we can move?

Mr. CLARKE. Indeed it would.

I think the multiplication of seed, getting into a field demonstration, using existing germplasm, and an opportunity to work out an economic model that would let us know where the problem areas are would be something that could be tackled without developing any new science, essentially.

We could take these and go to a demonstration phase that would at least point out the problem areas and let us see where we need to go.

Mr. DE LA GARZA. A. & M. is now working with that study being conducted out of El Paso. Is that right?

Mr. CLARKE. Yes, sir.

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We have some work there, and we have a little—smaller amount of work—with some initiation funds using State resources at College Station.

Mr. Bragg here has three additional studies that have been submitted for consideration to the National Science Foundation for additional funding.

Mr. DE LA GARZA. Thank you very much.

Is there anything else you would like to add to your statement?

Mr. CLARKE. No, sir; just to thank you again for the opportunity to be here.

Mr. DE LA GARZA. Thank you very much. We appreciate your being here.

I would like to mention for the record that note was made of the cooperation and funding made by the Southwest Border States Regional Commission.

I am very happy to see that its Federal cochairman, the Honorable Chris Aldretes, is with us here. We welcome you, Mr. Chairman. We appreciate your cooperation in this endeavor.

Our next witness is Dr. Noel D. Vietmeyer.

We are very happy to have you here, sir. We appreciate your cooperation.

I am informed that congratulations are in order from this group to you for having received this year's Academy's award for distinguished service for work on new plants such as guayule. So, I know that we are dealing with a top expert in the field. We certainly are very happy that you would participate in these hearings.

We welcome you and would like to hear from you at this time.

STATEMENT OF DR. NOEL D. VIETMEYER, PROFESSIONAL ASSOCIATE, NATIONAL ACADEMY OF SCIENCES

Dr. VIETMEYER. Thank you.

I would like to point out that the National Academy of Sciences recently studied guayule, and I was the staff director for the panel which did the work. It was a distinguished panel, half of whose members were familiar with guayule and the other half was deliberately chosen because they knew nothing, or very little, about it. They were the devil's advocates.

This was an exercise to look at guayule in a balanced and unbiased manner.

One of the major conclusions that I would like to leave with you is that the panel concluded that the quality of guayule rubber is extremely high. That is probably the most fundamental conclusion to bear in mind because a rumor has been around for several decades that guayule rubber is poor quality and second rate. That just is not true.

Certainly, there are historical reasons for the rumor. One is that in the old days the rubber was always sold in a sticky form. It had tars in it and degraded quite readily. That was a function of the tars and had nothing to do with the rubber.

Already, by the time of the big program in the 1940's, scientists had learned how to remove the tars to leave the solid rubber. You have seen samples. And I have a ball here which is actually 30 years old and still in extremely good condition. [Bounces ball.]

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So, there is no doubt that by removing the tars, you get a product of high quality and good longevity.

We, in fact, were lucky enough to find a block of guayule rubber on the shelves in the Federal Records Center in Suitland. It was a 50-pound block, and we had samples of it analyzed at Goodyear Research and at Bell Telephone Labs.

It is from that, plus some other samples we got from the Mexican pilot plant, which our data—which is included in a whole chapter here—on the quality of the rubber, is drawn. [Shows booklet.]

I have to say that the equipment that was used to determine this was the very finest and most sensitive available at the time, which was 1976.

I would like to say something about the feasibility study, which has loomed so large in the discussions here this morning.

Quite frankly, I do not think that the panel ever felt that it would be so important. Perhaps that is because they did not expect such a rapid increase of interest in guayule.

Although they did call for a feasibility study and a technology assessment, I think that the panel members would not have recommended delaying research until completion of such a study. Rather, they would urge that exploratory research efforts get underway immediately and that any feasibility study run concomitantly.

I think Dr. Clarke's paragraph that relates to this—at the top of page 7 of his testimony—is a very good summary of what our panel would have recommended.

Certainly, I would think that panel members would not wish the legislation delayed until any feasibility study was completed.

On another point, I would like to comment on the question of guayule research being solely in the jurisdiction of the Department of Agriculture.

Personally, I am amazed at the number of different institutions that have become so excited by guayule. I think it is crucial that we maintain that enthusiasm coming from organizations such as universities, the Los Angeles Arboretum, State agencies, agricultural experiment stations, and, of course, research laboratories, private individuals, and industry.

You can get a demonstration of the interest of industry from the tire that is at the end of the table here. [Shows tire.]

This is a guayule rubber tire produced by Goodyear. It has been running around in Akron, Ohio, all through the winter.

Mr. Brown's comments struck a responsive chord with me on the question of getting practical results by actually getting out there and doing a large-scale demonstration. This is a way to find out the real practical requirements this crop will need.

These comments of mine have varied very greatly from my written testimony, but I think that most of what is in the testimony is fairly well known already.

Thank you.

[The prepared statement of Dr. Vietmeyer follows:]

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Testimony concerning "Guayule"

by

Dr. Noel D. Vietmeyer

Study Director, National Academy of Sciences Panel on Guayule
Professional Associate, National Academy of Sciences
Washington, D.C.

I am pleased to be with you this morning and to have this opportunity to discuss guayule, a plant that is almost unheard of today, but that promises to make a major contribution to the nation's productivity and well-being in the near future.

It is heartening to see that the bill H.R. 12559 specifically authorizes "a program of research, development, and demonstration of guayule rubber production and manufacture as an economic development opportunity for southwestern states." Recently the nation has come to realize that underground resources of fuels and minerals are not unlimited. Never before has the United States faced such a compelling need for renewable resources. It is crucial to the country's long-term health--indeed, its very survival--that scientists begin intensive research into the wealth of plants that could be cultivated to produce the raw materials needed in the future.

Guayule is one of these. It is, as you know, a small shrub that looks like sagebrush and is native to desert-like regions of southwestern Texas and contiguous areas of Mexico. It produces rubber; in fact, in some varieties rubber comprises as much as one-quarter the weight of the stems and roots.

Over two years ago the National Academy of Sciences established a panel of distinguished botanists, agronomists, engineers, chemists, rubber technologists, and a rubber economist to investigate the potential of this exciting plant. It was my privilege to direct the work of this panel. Its findings have been published in a report, copies of which I am providing for each member of the subcommittee.

The study considered thoroughly the chemistry and quality of guayule rubber and found that it is a very high grade natural rubber indeed.

Many uninformed people believe that with synthetic rubber available from industry there is no longer need for natural rubber. This is not true. Virtually all tires contain natural rubber: Automobile tires average 20 percent, the new radials about twice that; truck and bus tires are at least 40 percent; and large tires on aircraft, tractors, and earth-moving vehicles are virtually 100 percent natural rubber. Natural rubber is used in the carcass of the tire because it runs cooler than synthetic tire rubbers and therefore degrades less, which ensures that our tires have fewer body breaks and longer lifetimes.

Although early this century U.S. corporations produced a large portion of the nation's rubber from guayule bushes growing in Texas and Mexico, today natural rubber comes from Southeast Asia and Africa and is produced entirely from the rubber tree Hevea brasiliensis. The world's demand for natural rubber is increasing so rapidly that economists are predicting that the rubber tree plantations cannot produce enough, and that natural rubber shortages will

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soon occur. From model calculations the Malaysian Rubber Research and Development Board concludes that the annual demand for natural rubber will outstrip supply by about 1 million tons in 1980, and by about 2 million tons in 1985. As a result, the World Bank expects prices to increase (in current U.S. dollar terms) from about 39¢ at present to about 60¢ per lb in 1980 and 78¢ per lb in 1985. The eventual result will be that the nation's consumers are going to have to pay substantially more for their tires and rubber goods. The virtual doubling in price will also affect our balance of payments; even at today's prices the nation spends about $500 million each year on natural rubber imports.

During its investigation, the NAS panel subjected guayule rubber samples to the most modern and sensitive tools of chemical structure elucidation. The results show conclusively that guayule rubber and hevea rubber (the type from the rubber tree) have chemical and physical properties that are virtually identical. Both guayule rubber and hevea rubber are hydrocarbons, both are polymers of isoprene, both have double bonds with a cis configuration (this gives the rubber its "bounce"), both are approximately the same in molecular length and weight. Both have very similar, or identical, microstructure: studies have not detected any differences, even with techniques that can detect as little as 0.5 percent of structural difference.

With the quality of the rubber assured, the panel addressed the question of the economics of its production. Unfortunately, with its limited budget of time and funds the panel could not draw detailed conclusions. Guayule was last cultivated decades ago, under wartime conditions and before discovery of many of our most powerful agricultural tools. Making economic projections from the old data is thus essentially meaningless. For example, controlling weeds was a major expense in the early 1940s; it was largely done by hand. Today, the use of organic herbicides has resulted in a large decrease in such expenses. Nonetheless, the panel could find no excessively costly step in producing guayule rubber. Guayule plantations are planted, cultivated, and harvested largely with machinery used in conventional agriculture. The cost of extracting the rubber may be high, but not excessively so. Guayule rubber sold competively with hevea rubber during the first half of the century, and now with modern technology, extraction efficiency and costs should, if anything, be less than before.

Thus, the panel concluded that not only is there a market for guayule rubber, but that it can probably be served while providing profit to the farmer and processor at the same time.

But this will happen only if we apply to guayule production the knowledge that science has gained during the past 30 years. In that time, major advances have been made in plant genetics, agricultural technology (pest control, weed control, mechanization, etc.), chemical instrumentation, chemical engineering, and rubber technology. There are now techniques, unknown when guayule was last produced three decades ago, that could revolutionize its production. Without the research effort intended in H.R. 12559 this crop's potential will not be met.

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The research needed is in guayule production--in the agricultural and process-engineering sciences. The rubber companies are not agricultural researchers and cannot be expected to do this. But the rubber industry is keenly interested in the idea of a domestic source of natural rubber. Based on industry projections, the panel is persuaded that a market exists for all the guayule rubber that could be produced at a competitive price.

No known rubber-producing plant seems to have the potential of guayule for producing domestic rubber. And guayule can be grown in the semiarid southwestern states. In 1944, the U.S. Forest Service classified 5 million acres in Texas, New Mexico, Arizona, and California as suitable for guayule culture. Although some panel members believe that under really dry conditions the plant may mature too slowly to provide a reasonable annual return on investment, nevertheless most panel members are convinced that because guayule is native to a desert environment it can be grown profitably where rainfall or irrigation supplies are unreliable. With current chronic water shortages in the southwest exacerbated by the amounts of irrigation water needed by conventional crops, guayule agriculture could become a boon to the region and could help bring relief to the water supplies there.

So you can see that guayule is a crop that offers promise of further increases in agricultural productivity and employment in subtropical and arid climates in southwestern states.

Guayule production also relates well to policies on energy independence (for instance, its rubber could substitute for petroleum-derived synthetic rubber), and on defense and emergency preparedness (aircraft tires, for example, are made virtually entirely from imported natural rubber).

Apart from guayule's potential to contribute to rubber production, the fact that it grows in semiarid land where opportunities for agriculture are minimal and employment opportunities are scarce gives the crop particularly interesting and exciting potential for satisfying national needs.

With this in mind, I take great satisfaction this morning in being able to recount to you the NAS panel's evidence of guayule's importance to our country's future. A commitment to guayule research and development is needed. H.R. 12559 provides the basic funding for this and will be the catalyst that brings the benefits of guayule to the nation.

Thank you.

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STATEMENT OF NOEL VIETMEYER, PROFESSIONAL ASSOCIATE

NATIONAL ACADEMY OF SCIENCES

Senate Committee on Environment and Public Works, March 1, 1978

Dr. Vietmeyer. I was the staff director of the National Academy of Sciences' panel on guayule. This was a distinguished panel, half of whose members were familiar with guayule, the other half were deliberately selected as devil's advocates. Thus the panel was deliberately set up to look at the modern potential of this plant in a balanced, unbiased manner.

One of the panel's conclusions, that I would like to leave in your mind, is that the quality of guayule rubber is extremely high. There has been a lot of rumor for several decades that guayule rubber was a poor quality and second rate. That is not true.

There are various historical reasons for that rumor. You see when the rubber first comes out of the shrub it is contaminated with sticky resins or tars. In the old days it was sold in that gooey form.

But during the guayule program in World War II, it was found that it is very easy to remove the tars using a simple solvent extraction process of the kind that we use to extract oils from seeds like peanuts and soybeans. Once you take the resins out, you get a very stable, higher-quality rubber.

In the NAS panel's report we have documented in detail the properties of guayule rubber, based on studies done at the University of Akron, at Goodyear Research, and at Bell Telephone Labs using the most sophisticated equipment. There is no doubt that the quality of this rubber is very high indeed.

Now, as to the question of economics. Guayule and hevea rubber are the only two natural rubbers to have been commercially marketed in any substantial way, and for the first 50 years of this century they were competitive in the market place. Our panel could not see any reason why guayule cannot be competitive again today. However, we have 30 years of catch-up to do in research, because hevea rubber has one of the most magnificent research programs of any agricultural product. Since World War II, Malaysia has increased the per acre production of hevea rubber something like tenfold.

In fact, our panel felt that guayule research can ride piggyback on the advances that have already been made in hevea rubber, because the biochemistry of rubber production is very similar, if not identical, in both of them.

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Guayule is a plant geneticist's dream. It is set up ideally to do plant genetics. Once you crossbreed it, there is a way to "lock in" the hybrids, so they can be replicated through seed without being degraded by cross-polination.

In responding to your former comments, Senator Bentson. I know that there is this feeling about the boondoggle of the World War II guayule project. But it was really a most magnificent research program. It is really tragic it hasn't had a good press.

Senator Bentsen. Let me say I am not saying it was a boondoggle. I am saying that is the impression I get, that is the way I read it.

Dr. Vietmeyer. That impression is still here. In one chapter in the NAS report we document the history. By reading the picture captions, you get an impression of the magnitude and scale of the work. There were more than a thousand researchers and technicians on that program and 10,000 workers.

However, just at the time when the bushes were ready to be harvested -- I forget how many million pounds of rubber were waiting to be harvested and processed -- the rubber-tree plantations in Southeast Asia were liberated. Rubber trees keep producing, you have to keep tapping them, so there was a large surplus of natural rubber which became available.

Secondly, the synthetic rubber industry was struggling to get on its feet. It had a very large federal price support because it was having a hard time getting started.

Senator Domenici. When the Department of Agriculture burned the fields in 1946 --

Dr. Vietmeyer. The Department of Agriculture didn't burn the fields. What happened was when Congress withdrew the funding, the farmers then had no way to get rid of their crop. In any case many wanted to plant cotton or something else, so the farmers burned their own fields.

Senator Domenici. Now the fields at that point in time were literally destroyed.

Dr. Vietmeyer. Yes. There was enough rubber to put tires on 20 percent of the cars that Detroit produced in that year, and it just burned up in smoke.

Another thing to note is that this was the era of manmade "wonder" materials. It was the time of penicillin, DDT, 24-D, and other pesticides; manmade things were considered the wave of the future. People thought that natural products were going to be supplanted. For example synthetic rubber was the modern thing, and people thought that we didn't need a third

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source of rubber. That is really why the guayule funds were withdrawn.

The feeling of its being a boondoggle is because the fields were burned that way, which was nothing to do with the guayule technology or rubber quality. It had to do with the times, and the times have now changed.

I would like to say that we know that the production of guayule rubber will work. All of the steps in production of guayule rubber have been done in the past. But what we need to do now is to apply the 1978 technology to it.

Quite a few of the techniques that were used to produce rubber from guayule in the '40s actually go back to 1902, because the need for rubber in 1942 was so critical that the Forest Service was told not to go back and do research, but put into practice what was known.

What was known came from one rubber company, and it was based on the process developed in 1902 by a mining engineer. So the processing techniques used in the '40s were actually designed in 1902. That is why Dr. Bragg said it was crude.

Senator Domenici. Let me back up for a minute.

What prompted this study?

Dr. Vietmeyer. My program is set up at the National Academy of Sciences to look for lesser known areas of science, neglected areas of science, that seem important. We have had a lot of success in talking to botanists and finding crops that are not getting recognition. Guayule came to attention in one of those studies. It seemed to have so much promise that we decided to gather a panel of people from the old program and some devil's advocates, put them together for three days, and let them work it out and then see what the results were.

Senator Domenici. I want to stop you and give you some observations and one more question.

First, I want to say to you I don't know if you know Dr. Ritchie who worked as a fellow on my staff, but he was part of the study group. I think I want to say right now for the record, and to some extent since you work a lot and end up with sometimes fruitful results and sometimes people throw it away, I really intuitively feel we have something that is going to work, and I really commend you for it. I believe had you not promoted this, and in turn young Dr. Ritchie, I don't think we would be here today.

I know we are going to have a problem as to what program and how much. It just appears to me that the doctor is right, the time is now. The world situation has changed. Your description of what has changed is so.

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And the need for a new crop that doesn't need a lot of water is jsut imminent in the high plain states. I commend the Academy for their efforts in this process.

Dr. Vietmeyer. Thank you, Senator.

Senator Domenici. How much did it find out from the rubber companies of America as to their interest in this program? If it works, it seems to me they ought to use American products, considering the balance of payments problem and the cartel potential. Are there any build in inhibitions that we are aware of that relate to business ties or processing that they wouldn't want to change?

Dr. Vietmeyer. Well, one of the most impressive things to me has been the industry's response. Mr. Pierson, who I think is going to be speaking soon, was a member of this study group, and he can speak to that better.

Goodyear, Goodrich, and Firestone have all identified senior executives to be there guayule coordinators. They seem to have apparently a very intense interest in the potential of this crop.

Senator Domenici. I want to ask one more question, then I want my professor from New Mexico to have his turn here.

In reviewing the testimony, several of the witnesses indicate that there is a growing world demand for natural rubber, and right along with it an increase in the price. Will not the foreign market respond to the price increase with higher production making it rather impossible for guayule to gain a toehold?

Dr. Vietmeyer. I don't know all the aspects of this. I think Mr. Pierson can expand on it.

I would say hevea has a very narrow environmentally ecological nitch: It has to be grown close to the equator, in humid areas where the rainfall is 100 inches or so. So it is restricted to a narrow part of the world.

Secondly, it is a tree which takes a long time to mature. So even if you find there is a need for more rubber, there is many years' delay before you can get it in production.

Also there are other crops competing for land where hevea is grown. For example, I understand quite a few rubber trees have been pulled out for oil palm and other products.

Senator Domenici. Thank you very much.

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Mr. DE LA GARZA. Thank you very much, Doctor.

For the record, would you briefly describe the process of how the latex is extracted from the shrub, what processes it goes through, and the difficulty or easiness with which it is extracted?

There you have a shrub. How do we get the rubber out of the shrub?

Dr. VIETMEYER. In guayule, the rubber is held in separate cells. On page 27 of our booklet is a diagram that shows the separate cells containing rubber.

Mr. DE LA GARZA. By booklet, you mean?

Dr. VIETMEYER. The National Academy of Sciences pamphlet. There are copies here.

Mr. DE LA GARZA. That will be made a part of the record. I do not know if it will be proper to reproduce your whole pamphlet, but we will file it with the papers of this hearing and maybe quote from it as necessary.

[The booklet, "Guayule: An Alternative Source of Natural Rubber," is held in the subcommittee files.]

Dr. VIETMEYER. We would be delighted.

To get the rubber out of the cells, you have to shred and pulp the whole shrub. Normally, the leaves are removed by treating them with hot water, and then the stems, roots, and branches are pulped the way we would pulp pine trees for making paper.

In the traditional method, which in fact was devised by a mining engineer in 1902, the pulped material is pumped into a vat. The water-logged vegetation sinks, and the rubber floats. It floats in a form that is called "worms." These "worms" can be decanted. They come off contaminated with the resins which I mentioned earlier.

This was the system used by the commercial guayule rubber companies right up through World War II. During the war program, there was not enough time to go back and reinvent an extraction technique. The Forest Service was told to produce rubber by known methods and not to delay.

However, with the recent renaissance of interest in guayule, researchers have been looking at alternative techniques. One of the most exciting appears to be the extraction of the rubber using solvents. This would avoid the flotation separation, and certainly seems to be an extremely promising new technique.

Mr. DE LA GARZA. Which of those processes is being used at the pilot plant in Saltillo, Mexico?

Dr. VIETMEYER. Basically, they use the flotation technique. They have incorporated some very modern methods developed by the synthetic rubber industry, but these come more in the purification steps which come after the flotation separation.

Mr. DE LA GARZA. This is a natural rubber plant. But with the historical natural rubber plant—the tall tree that grows in Indonesia and Ghana—how is the process different?

Dr. VIETMEYER. Guayule comes from an entirely different family of plants. In the Hevea tree, the rubber is in long ducts. You slit the bark, and the rubber pours out. In guayule, the rubber is held in separate cells, and so you cannot tap it that way.

Mr. DE LA GARZA. Which process would be, I don't know if you could call it, a better process, but which is more difficult provided you could handle the plant automatically?

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Dr. VIETMEYER. To harvest rubber from the rubber tree, you have to use hand labor. There has been consideration of how to mechanize it, but apparently nothing seems remotely feasible. Guayule can be completely mechanized—completely handled by machines. So, guayule is the crop better suited to U.S. agriculture.

Mr. DE LA GARZA. The other process takes a man with a little bucket and hatchet to go to every tree?

Dr. VIETMEYER. Yes; it requires a considerable amount of skill too. If he cuts too deep he damages the tree.

Mr. DE LA GARZA. So, your findings have shown you that if the mechanization process for the harvesting of the guayule plant and the utilization of the plant to extract the latex could be mechanized to such an extent it would revolutionize the rubber industry, as far as getting the raw material is concerned.

Dr. VIETMEYER. Yes; certainly it can be mechanized. In fact, it was already mechanized in the thirties.

Mr. DE LA GARZA. Mr. Brown?

Mr. BROWN. Dr. Vietmeyer, I appreciate your testimony and contribution to this whole subject through your work at the Academy.

I have been reading through the testimony that you made before the Senate committee attached to your statement. It is rather interesting.

You made the observation in that testimony that synthetic rubber at its inception, during that period when I guess we thought man could create anything and did not have to rely on natural products anymore, was encouraged by substantial Federal price subsidies.

My memory is a little hazy on this. Do you think it would be possible to investigate and determine the actual amount of Federal subsidies that might have gone into the synthetic program at the early stages? Would there be some way of pulling that information together?

Dr. VIETMEYER. This is beyond my experience, but I think that it must certainly be a matter of record somewhere.

I have heard enormous figures quoted, but I have not actually documented them. I have heard them from several sources.

Mr. BROWN. Would they be as large as $60 million?

Dr. VIETMEYER. I have heard of figures far higher than that.

Mr. BROWN. $600 million?

Dr. VIETMEYER. Yes; but I have not documented them.

It is true that the time when the program was abandoned in the 1940's was an era of the manmade wonder drugs—DDT, penicillin, other antibiotics, herbicides such as 2,4-D, and so on. There was a feeling at that time that manmade molecules were modern—that they were the wave of the future. All natural products were going to go the way of indigo and other natural products that had become completely obsolete.

I think guayule was a victim of that thinking.

Also, the Japanese had had control of essentially the whole world's rubber supply for several years. So, this meant that there was excess rubber which just piled up on the docks in Southeast Asia. So, by 1946, there was a glut of rubber. This, coupled with the feeling about manmade molecules and the fact that the synthetic rubber industry

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was struggling to get established, all came together, and nobody could see any reason to have a third source of rubber—guayule.

Mr. BROWN. I am sure one of the arguments we are going to hear against funding research on guayule is that we have this tremendous synthetic rubber, private enterprise business which gets along without any Government help, and why should we put any Government money into starting something to supplant or replace it at some point?

I think it is important for the record to show that this great industry got its start through a heavy infusion of Government support also. It may, of course, because of circumstances beyond its control, be pricing itself out of the market before long.

You had some other interesting observations about the research in guayule—that a great deal of that research could piggyback on the research already done on Hevea. That has been thoroughly researched.

I presume, basically, with regard to problems such as the chemical and molecular composition of rubber, and things of that sort, most of the research has been done. Is that where most of the research has been done in improving it, or has it been done on the genetics of the rubber tree?

Dr. VIETMEYER. It has been done on the genetics of the rubber tree.

The Rubber Research Institute of Malaysia has done an absolutely marvellous job with the rubber tree—one of the most outstanding agricultural projects of all time. It has increased the per acre yield of rubber more than tenfold in the last 30 years. This is mostly through genetic research, and partly through hormone stimulation.

We heard this morning about Dr. Yokoyama of the Department of Agriculture who has found a hormone that will work similarly with guayule.

My comment was that because the biochemical production of rubber is very similar in both plants, we can probably take advantage of, and ride piggyback on, this marvelous research that the Malaysians have done.

Mr. BROWN. This is not U.S. research on Hevea? We would not be directly concerned with the genetics of the rubber tree?

Dr. VIETMEYER. There was at least one American professor who was a consultant to the program, but basically it was Malaysian scientists who did that work.

Mr. BROWN. Again, to complete our record, it would probably be interesting to find out the amount of support given by Japan and Malaysia and other rubber-growing countries to research on hevea just as a means of comparing those efforts with the efforts we might make in guayule, and likewise for other crops which have been the subject of considerable research support.

I think a policy judgment as to whether we ought to support research in guayule really ought to be based upon a comparison of the payoff in comparison with similar investments in other crops and the payoffs in those situations—corn, wheat, soybeans, and you name it. They have all been the subject of extensive Government-funded research, if I am not mistaken.

Can you confirm that?

Dr. VIETMEYER. I believe it is true. Again, that is not my field.

Mr. BROWN. We have been doing something with all this research money that goes to the Department of Agriculture?

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Dr. VIETMEYER. Perhaps I could make one comment about synthetic rubber. You said that people might say, "Why should we spend this money when we have synthetic rubber?"

It should be clearly understood that there is a wide range of different molecules called synthetic rubber. In fact, technically they are called elastomers and not rubbers at all.

Most of them have properties that do not suit them to the major use of natural rubber which is in automobile tires. As my written testimony says:

> Many uninformed people believe that with synthetic rubber available from industry there is no longer need for natural rubber. This is not true. Virtually all tires contain natural rubber: Automobile tires average 20 percent, the new radials about twice that—and radials are rapidly dominating the market—truck and bus tires are at least 40 percent; and large tires on aircraft, tractors, and earth-moving vehicles are virtually 100 percent natural rubber. Natural rubber is used in the carcass of the tire because it runs cooler than synthetic tire rubbers and therefore degrades less, which insures that our tires have fewer body breaks and longer lifetimes.

So, it is largely a question of the poor characteristics of these rubbers—their technical imperfections—which gives an extremly strong market position to natural rubber.

Perhaps you saw in Fortune magazine, about two issues ago, the article entitled, "Natural Rubber Has a Future After All," or something like that. It documents the increasing demand for natural rubber and the coming expected shortage in the 1980's and 1990's.

Mr. BROWN. Dr. Vietmeyer, may I just ask one final question?

Dr. VIETMEYER. Certainly.

Mr. BROWN. Your testimony is to the effect that the Academy, in its study, was not recommending any delay in moving ahead with the program on this, and that the thrust of the Academy's study would be compatible with moving ahead on a full-scale research program, possibly of the nature described by Dr. Clarke with a combination of short-run and long-run research, while any investigations of feasibility or environmental impact were going on concurrently. Is that correct?

Dr. VIETMEYER. That is certainly my understanding of the panel's feelings and conclusions when they did this report.

Mr. BROWN. Thank you very much.

Mr. DE LA GARZA. Thank you very much, Doctor. We appreciate your being here as well as your cooperation. We want to commend and congratulate you on the fine job of research you have done so far in this respect.

Dr. VIETMEYER. Thank you very much.

Mr. DE LA GARZA. Our next witness this morning is Mr. Edward Flynn of California, one of the earliest "guayuleros." I guess.

Mr. BROWN. One of the what?

Mr. DE LA GARZA. "Guayuleros." That is what they call people who have been working on guayule.

We welcome you and would hear from you at this time, sir.

Mr. FLYNN. Thank you very much, Congressman.

Mr. Brown, I was delighted to hear you say this morning what you did about your activity 15 years ago. I saw you struggle with Hugh Anderson many, many times in trying to stimulate and encourage the growth of guayule. I want to pay credit right now to you and Mr.

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Anderson, because without your persistence, and particularly Mr. Anderson's persistence, none of us would be here today.

It was only by the dogged determination of Mr. Anderson that he put together the package that he did many years ago to try to encourage this operation.

So, what we have here today is an accumulated result of your work along with his.

In the interests of time, I would ask to have my statement put into the record, and I would like to highlight a few observations based on what I have heard this morning.

Mr. DE LA GARZA. Without objection, your full statement will appear in the record at this point.

[The prepared statement submitted by Mr. Flynn follows:]

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STATEMENT OF EDWARD J. FLYNN, MARKETING EXECUTIVE, SAN MARINO, CALIFORNIA

I am Edward J. Flynn, of San Marino, California, a marketing executive with more than twelve years' experience working towards developing guayule. I have worked in Mexico, Australia, Spain and Turkey and have seen guayule go up and down, and today I am looking toward the up curve.

I am grateful for the opportunity of appearing before your forward looking committee and sharing with you some thoughts on the development of guayule, an action which has been speeded up with our current energy crisis and other factors.

Distinguished scientists, agronomists, professors, industry and government representatives will outline for you the various scientific, agronomic and production aspects of guayule growth and activity while I would like to look toward the marketing and various other aspects.

In 1942, an esteemed colleague of yours, Congressman W. R. Poage, of the 11th District of Texas, had the wisdom and foresight to do exactly what you gentlemen are doing with this present bill for the Commercialization of Latex. He knew from his youth in Texas that guayule had a great future but unfortunately for our country, his colleagues did not possess the same wisdom and foresight, and his bill went down to defeat. This shortsightedness deprived our nation of a valuable, renewable resource as well as the opportunity to develop our own natural rubber industry.

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I trust this will not happen again and pray that the wisdom of this great Congress will be brought to bear to insure that the lessons of the past will have been learned and used to insure the passage of this legislation.

Scientists, genetecists, egronomists and others working on research in this field tell us that it is an adventure in science and holds great potential for our country. We can develop our own natural rubber industry and create from the by-products of guayule job-creating industries on products that have been tried but are still untested.

At one time in this country, Salinas and Bakersfield, California as well as some test areas in Texas, had more than 9000 workers and 1000 scientists working to produce some of the best rubber in the world. The production of more than 15 tons per day for over four years convinced many of us that guayule had a future and could form the basis of a natural rubber industry in this country if given the proper opportunity.

I believe this now can be done.

The rubber industry is vital to the economic health of this country and the addition of guayule to this great industry can spin off many jobs as well as provide a renewable resource with no dependence on foreign sources and at less cost than present resources.

The major rubber companies by their presence here today and their continuing support over the last two years and in prior years demonstrate their interest in guayule as a source of natural rubber if the economics make sense to them.

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The rubber specialty products industry has been surveyed by me and more than 75% of those queried indicate a use for guayule if the quality is equal to present stocks and competitive in price.

The Department of Defense and the National Preparedness Agency have indicated the desirability of a domestic rubber supply for defense and stockpile needs.

The Department of Energy has indicated their interest in guayule as a source of energy and are prepared to consider research in the field once sufficient stocks are available.

Thus, it is apparent that the continuing interest in guayule as a source of natural rubber indicates a market once the product is proved equal to present stocks as well as competitive in price.

We therefore feel that in order to meet the objectives of this legislation, "Commercialization of Latex (guayule)", we should recognize and acknowledge the excellent work which has been done during the last four years which has aided greatly in speeding up the commercialization process.

At the University of Arizona at Tucson, stands and test plantings have been established and similar activity is being done at the Los Angeles County Arboretum in Los Angeles. Emergency Rubber Project alumni tell me the work is equal to any which was done in the early days of guayule in this country.

Working in tandem with this group is Dr. Henry Yokoyama, distinguished scientist at the U.S.D.A., Citrus Laboratory in Pasadena, California, who has conducted studies which have already increased rubber yield from his applications and use of chemical agents.

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Thus, with advanced technology, modern agricultural methods, and new chemical agents, we are light years ahead of the emergency rubber project at a similar stage in their growth and yet, have the mountains of data from that project to draw on for support in developing this operation.

In order to meet the objectives of Section Five of the legislation, one of the immediate steps would be plantings on a graduated scale, following feasibility studies, to insure a sufficient and ready resource of high quality shrub.

These plantings could be carried out in the four Southwestern states where soil, climate, precipitation, are suitable for guayule growth and where it has been grown in the past and where the pattern of behavior is well known. This would save considerable money, time and, more importantly, stimulate and encourage the continued development of guayule among the private sector.

This can only be done if and when the vast resources of the various government agencies, educational institutions, rubber companies, private sector groups, and individuals unite in a forward looking movement to support the development of a natural rubber industry in this country.

Your bill is a forward step in that direction and I would urge its passage.

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Mr. FLYNN. I have looked at guayule in Australia, Mexico, Spain, and Turkey. I certainly hope that the suggestion by the Academy about the feasbility study does not stand in the way of moving ahead with the basic research which is needed.

Dr. Clarke hit it on the head this morning in terms of our continuing to operate while the feasibility study would be conducted.

I go along with what you two gentlemen said. Here is the plant, and here are the results. The tire has been running around Akron this winter.

The thrust of my testimony, essentially, is that we should start planting.

If the funds are available to go to the 50,000 acres that you talked about, Mr. Brown, I know there are people in California who would be willing to assist in the underwriting of the planting of 50,000 acres. In the many years that I have been investigating the idea of the growth of guayule, many, many ranchers have talked to me about again planting as quickly as possible, because if we did not Dr. Clarke and Dr. Yokoyama would not have the stocks with which to experiment.

This is the same for the other agencies who want to experiment. They need stocks, and the only way they can get them is to plant them.

So, essentially, I am saying that if we do need a feasibility study, that is fine. I think it can be conducted along with the possibility of planting 5,000, or 10,000, or 15,000 acres in Texas, New Mexico, Arizona, and California—hopefully California, of course.

We grew lots of guayule in Salinas and Bakersfield, as well as in parts of Texas. And in those years, we put a lot of people to work. We can do it again. I think that is one of the thrusts of the legislation—to build up jobs in those four States as well as others and, at the same time, assist the Indians in their development.

I am already attempting to do that and am hopeful that we can do something with the Navahoes. I have been to Arizona in the past month to talk with Indians about the possibility of doing something with guayule.

On the other hand, I can see the restraints that Dr. Cowan is under from the Budget Office, but I would be terribly unhappy if those restraints caused it to go the way of the prior emergency rubber project and held us back from continuing to develop this thing.

As Dr. Vietmeyer said, there are many, many people interested in guayule. I know this from my guayule newsletter which is now going all over the world. As a result, I get letters from all over the world asking for more information, asking what can be done with guayule, and "when can we plant it?" That is most essential.

On the side of the extraction, in Pasadena, the Jacobs Engineering Co., a well-known engineering company which does paper pulp processing building, has been interested in the development of guayule since 1972, thanks again to Mr. Anderson.

They have put two men to work on the possibility of improving the extraction methods which were used in the past. Everyone in this room knows that with the advanced technology which is available, it is not very difficult to improve on what was done in the 1940's.

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I have no further testimony, but I would be happy to answer any questions you may have.

Mr. DE LA GARZA. Thank you very much.

Have you any questions, Mr. Brown?

Mr. BROWN. Yes; I have just a question or two, Mr. Flynn.

I appreciate your being here and giving us the benefit of your own large contacts among those in the community of interest in guayule.

One of the problems, it seems to me, that has been touched on here is that we had a reservoir of knowledgeable people who were involved in the Emergency Rubber Project in many ways. Mr. Anderson was one of those, and there were many scientists, and so on, but unless they were extremely young at that time, most of those people have passed on or are in retirement. Any knowledge and background that they may have developed during that period is rapidly becoming unavailable.

I make that as a statement, but I would ask you if that conforms to your own background of knowledge of these people, Mr. Flynn.

Mr. FLYNN. Yes; except that there are a lot of them around. I talked to Harris Benedict, Jim Bonner, and Ken Taylor last week and Dr. McGinnies at Arizona.

It is true that they are aging, but so are all of them. If we, in the next 2 or 3 years, begin to develop guayule, we will have the benefit of their experience and background.

There are still a lot of them available, willing and anxious, I would say, based on what Ken Taylor said, to lend their expertise to the effort which is going on now, as is Dr. Benedict.

Mr. BROWN. You mentioned the fact that our distinguished colleague, Mr. Poage, actually was one of the earliest persons interested in this. He introduced legislation back in 1942 on guayule. Yet, this year marks the end of an era as far as Mr. Poage is concerned—he is retiring from Congress, and we will no longer have the benefit of his own vast knowledge about the legislative aspects of this problem. And there are many more in the same situation.

Mr. FLYNN. Mr. Whitten was also very helpful in those days, and I would agree with you. I would not want this to be delayed much longer because the longer we do, the less advantage we will have of these gentlemen's experience and wisdom.

Mr. BROWN. You indicated, and there has been some press attention to this but it has not been brought up in the hearing so far, that the Department of Energy has expressed an interest in guayule as a source of energy. It seems to be true that the chemical composition of the shrub is such that you can develop a gasoline-like substance from it, as I understand it, and I am a little fuzzy on this.

Could you comment on your understanding of the basis of the Department of Energy's interest in guayule?

Mr. FLYNN. I talked to a representative of the Department on Thursday last. They are developing guidelines for proposals for guayule based on a little work which has been done by Dr. Calvin of Berkeley.

He has, with his tremendous background and being a Nobel Prize winner, stirred them and the imagination of Dr. Schlesinger to the idea that guayule has possibilities from the standpoint of extraction of oil.

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I am not a scientist, and I cannot dwell on that side of it, but I have had enough conversations with DOE people to indicate that since last year when I was here in Washington talking to them about guayule, their attitude has changed. They now have considerable interest in guayule as a research possibility, especially in California.

They have encouraged Mr. Brown's Department of Energy to look into this. I have met with the staff people.

Despite the unfortunate proposition 13 in California—excuse the expression—there are still some funds available for research in energy. They are pursuing guayule as that possibility.

Mr. BROWN. If California and Governor Brown drop the ball, maybe Texas could pick it up and carry on.

Mr. FLYNN. I am sure they will.

Mr. DE LA GARZA. Thank you very much.

We appreciate your cooperation. It is nice of you to be here with us.

Mr. FLYNN. Thank you, sir.

Mr. DE LA GARZA. We have a communication which, without objection, we will place in the record. It is a statement by Mr. Leslie Baird of California.

Without objection, it will appear in the record.

With that, the subcommittees will stand in recess until 2 p.m. this afternoon.

[Whereupon, the hearing was recessed until 2 p.m.]

AFTERNOON SESSION

Mr. DE LA GARZA. The subcommittees will be in order.

Our first witness this afternoon is William P. Miller of the Office of Tribal Resources Development in the Bureau of Indian Affairs.

Good afternoon.

Mr. Miller, we welcome you and will be happy to hear from you at this time.

STATEMENT OF WILLIAM P. MILLER, OFFICE OF TRIBAL RESOURCES DEVELOPMENT, BUREAU OF INDIAN AFFAIRS, U.S. DEPARTMENT OF THE INTERIOR

Mr. MILLER. Thank you, Mr. Chairman.

I appreciate the invitation to appear before your committee this afternoon and express my independent views on the proposed bill, H.R. 12559, cited as the "Native Latex Commercialization Act of 1978."

These hearings concerning this bill have as their objective to authorize the Secretary of Agriculture to carry out a program of research leading to, and culminating in, the commercialization of latex from Parthenium.

The passage of this bill, cojoined with the passage of S. 1816, the "Guayule Rubber Demonstration and Economic Development Act of 1978," is an imperative and essential step in the legislative process which will expedite a Federal effort to develop a domestic renewable resource of natural rubber.

H.R. 12559 authorizes the Secretary of Agriculture to direct and carry out the objectives of the bill. S. 1816 authorizes the Secretary of

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Commerce to initiate and carry out research, development, and demonstration projects leading to, and culminating in, the commercialization of natural rubber from the guayule plant.

From these statements, it is obvious that although these two bills have the same objective, that is, the commercialization of guayule, the conflict of which Department should be authorized to coordinate and direct this development needs to be resolved.

In my opinion, both Commerce, which is mandated by Congress to promote and assist business and economic developments, and Agriculture have important roles to play in this effort.

Hopefully, a resolution can be found so that both Departments could work together to commercialize guayule. Within this context, I strongly support and urge the passage of H.R. 12559. However, I recommend that the following language be included under section 9(1), line 22, page 5, after the word, "organizations," to include: "including federally recognized Indian tribes."

The purpose of this recommendation is to assure that the recognized Indian tribal governments, who have land and a desire to cultivate guayule on their reservations, will be eligible, in cooperation with individual guayule scientists and/or private corporations, to receive direct grants and contracts under the provisions of this act.

In my view, this is essential. The socio-economic implications of guayule development projects on Indian reservations in the Southwest will have many positive effects.

As such, I have been asked to speak this afternooon about some of these possible or anticipated socio-economic benefits of guayule development for Indian tribes living in the southwestern United States.

Before doing this, I think it would be useful to place my remarks in context by reflecting, just briefly, on several pertinent facts which relate significantly to my assessment of the potential impact of guayule agriculture development on Indian reservations.

First, because there have been no recent scientific studies made on this subject. My conclusions are very general and are based on information extrapolated from socio-economic impact studies pertaining to jojoba agriculture on Indian reservations and the published economic analysis of guayule production during the emergency rubber project in the 1940's.

Second, in my judgment, based on recent General Accounting Office reports, most Indian reservations in the Southwest are facing a critical economic development crisis. For this reason, the Government should take every initiative possible to evaluate the feasibility of new business opportunities for Indian people and to formulate projects which could have the potential for significantly easing the high unemployment and underemployment rates, which are as high as 40 to 60 percent on some of the reservations in the Southwest.

Third, 18th century North American Indians used guayule rubber balls, procured by communal chewing of the bark of native guayule. In recent years Indian tribes have shown a high propensity for developing new crops which have been an integral part of their past economic and cultural history, for example. jojoba, tepary, chia.

Fourth, these remarks represent my own views of this subject and do not necessarily represent the views of the Bureau of Indian Affairs or of any Indian tribe.

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Within this context, the possibility that it would be commercially feasible to produce natural rubber domestically on the more than 500,000 acres of Indian land in those designated guayule areas of Texas, New Mexico, Arizona, and California is an exciting prospect. It could have significant, advantageous, and critically important socioeconomic and sociocultural implications for accelerating native American development.

Initially, for example, the development of a guayule cultivation and processing test facility on an Indian reservation, during the initial research and development phases of a U.S. guayule commercialization effort, could provide significant employment and training for Indians in guayule processing.

If this phase were successful, the consequent development of guayule plantations, processing mills, and rubber production facilities with staffing by Indians, would have a significant effect upon the economy and lifestyle of the Indian population in the Southwest.

Changes, for example, in Indian work habits, leisure activities, values, traditions, attitudes, and expectations for future reservation growth and development are bound to be influenced if tribal governments make a decision to participate in an effort to research and develop a domestic source of natural rubber.

Large areas of presently unproductive arid and semiarid lands in the Southwest could be put to productive use through a viable new crop such as guayule. Of course, this is not specifically restricted to Indian reservations, as all farmers in the Southwest would benefit by such a development.

The prospects for this new crop as a new renewable resource would broaden and diversify the base of Southwest agriculture. Inasmuch as guayule development, for the most part, would be on lands that are marginal and/or nonproductive for presently available crops, such as cotton, guayule agriculture would be noncompetitive with current crops.

The establishment of a guayule agribusiness on Indian reservations would have a marked social impact in reducing the present high social overhead costs which the Federal Government now provides tribal governments in the Southwest.

A currently developing crisis on reservations is the growing need for the education and training of skilled, professional agricultural scientists and engineers to solve existing agriculture problems.

Coupled with this is the pressing need to identify other agricultural crops which can employ these professionals. The development of a large-scale guayule program, on reservations, could aid in a solution to this problem by incorporating a scholarship incentive program for Indians to pursue careers in the agricultural sciences.

As mentioned previously, unemployment among Southwest Indians is around 40 to 60 percent, and it is likely to increase unless new industries are developed on the reservations.

Therefore, a guayule industry could have the potential to ease this high unemployment problem on at least a few reservations in the Southwest. Given that the Indian population in the Southwest is increasing by 3.5 percent per year unemployment conditions could be reduced with the development of this new industry.

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In addition to potentially providing employment, increased income, and the development of new skills and technology, an Indian guayule development effort would provide an opportunity for Indians to participate from the beginning in a national effort to develop a domestic source of natural rubber.

The significance of such an involvement has already motivated tribes in southern California to explore the feasibility of cooperating with a large private rubber corporation to establish guayule plantations on their reservations.

In addition, the diversity of byproducts from producing guayule rubber on reservations would allow the development of other Indian skills. For example, the woodpulp could be used to establish paper, plywood, and/or fuel businesses. Wax from guayule leaves has many uses. Uses for resins have not been fully explored but show good promise and the seeds could be used in pet and animal feed.

The growing water crisis on reservations in the Southwest, because of increased human populations and rapid depletion of underground water resources, makes it imperative to consider arid and semiarid crops, like guayule, which make minimum use of irrigation waters.

Guayule could be used on lands going out of cotton production because of the high energy use and cost of pumping water from deep depths. The lowered use of pumping could raise the water table while, at the same time, producing a commercial guayule crop.

Inasmuch as water is and will be a problem to the Southwest, it is essential to consider crops which maximize economic returns while conserving and optimizing the use of scarce Indian-owned water and energy. Crops such as guayule are promising in this respect.

The problems in establishing guayule as a new agriculture and industry to provide additional economic and employment opportunities for Indians are formidable and would require continued support by the Federal Government for a prolonged period of about 5 to 7 years.

As a national research and development project, the plant breeding problems of zero resin content, increased rubber quality, increased cold hardiness, higher yields to perhaps triple present yields, and other desirable characteristics should be attacked by scientists vigorously.

Other biological and agricultural problems should be considered simultaneously. The chemical and rubber extraction research should be pursued in an operating rubber mill. Uses and weaknesses of guayule rubber should be researched simultaneously.

However, and in conclusion, the training of Indians to do some of these tasks should be encouraged by institutional graduate training grants for and by in-service counterpart training in the production of guayule rubber. Sound, forceful, continued, and innovative leadership is called for. These are difficult problems, and it would be folly to underestimate their difficulty.

Thank you for the opportunity to testify on H.R. 12559.

I will be happy to answer any questions you or the members of the subcommittees may have regarding the statements I have made.

Mr. THORNTON. Thank you very much, Mr. Miller.

Mr. Miller, the present range of guayule is being extended somewhat from locations in the Southwest. Do you anticipate any improve-

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ments which might make it more possible for guayule to grow even farther north? Have you any difficulties in the area with which you are familiar in growing guayule as a wild plant?

Mr. MILLER. Although I am not an agricultural research scientist, I did participate on the initial National Academy of Sciences panel on guayule and have consulted with a number of guayule scientists on this subject. As such, my reply reflects what I believe to be current scientific thinking on this question.

As I understand it at the present moment, because there has not been a cold hardy strain developed, guayule agriculture is limited presently to what is referred to as "the guayule zone" in Texas, Arizona, California, and possibly some southern portions of Nevada, and New Mexico.

However, scientists funded by the National Science Foundation and the Four-Corners Regional Commission at New Mexico State University, the University of Arizona, and the University of Nevada are now working on a project to breed a cold-hardy strain. Right now guayule agriculture is restricted to the so-called guayule zone.

Mr. THORNTON. The guayule zone which you described is also a zone which, for the most part, is water deficient for agricultural purposes.

Has any study been made of the requirements for irrigation or accenting or developing further water supplies for commercial growth of guayule?

Mr. MILLER. Specifically developing water supplies in those areas in anticipation of growing guayule?

Mr THORNTON. That is right.

Mr. MILLER. To my knowledge, I do not think there is any effort at this particular time to develop specific water supplies for the development of guayule. However, if one could extrapolate from research on jojoba, which takes about 2 acre-feet the first year and approximately 1 acre-foot the second year, I think guayule is similar. But if one considers that forcing more, or giving more, water to the plant possibly will give greater yield, I think one would certainly have to consider the availability of existing water supplies. Certainly, it would be a handicap if sufficient water were not available to support a domestic effort to produce natural rubber.

However, there are some water projects, provided they are not cut, that may solve this problem.

Mr. THORNTON. I was hoping you might say something to that effect.

I want to thank you very much for your good testimony.

Mr. MILLER. Thank you, sir.

Mr. THORNTON. Our next witness is Mr. Jack Riedl, general manager, plantation operations, of the Goodyear Tire and Rubber Co.

Mr. Riedl, welcome to our hearing. We will be pleased to receive your testimony.

Without objection, your testimony, as presented to the subcommittees, will be made a part of the record in its entirety.

[The prepared statement submitted by Mr. Riedl follows:]

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The Goodyear Tire & Rubber Company

Akron, Ohio 44316

Remarks on H.R. 12559, Native
Latex (Guayule) Commercialization
Act of 1977

by J.J. Riedl
General Manager, Plantation Operations
The Goodyear Tire & Rubber Company

Before the Subcommittees on Agriculture and Science, Research and Technology, U.S. House of Representatives
Washington, D.C.
June 19, 1978

Mr. Chairman, members of the committee, my name is J.J. Riedl. I am general manager of plantation operations for The Goodyear Tire & Rubber Company of Akron, Ohio. I appreciate this opportunity to comment on the proposed Native Latex Commercialization Act.

As the world's largest consumer of rubber, Goodyear is naturally interested in encouraging any program that increases the competitiveness of natural rubber and assures its long range supply.

Our current interest in guayule goes back about 2½ years.

Studies we've conducted, while not as complete as we would like, show no significant structural differences between extracted and purified guayule rubber and Hevea rubber.

The raw polymer properties of the guayule rubber we tested compared favorably with the majority of the Hevea rubbers. The property differences that do exist can probably be corrected by changes in the techniques used in compounding the raw polymer.

Goodyear has produced experimental passenger tires with guayule replacing Hevea rubber in all components where natural rubber was required.

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This experimental winter radial tire, for example, contains from 35 to 40 per cent guayule rubber.

The guayule tires we produced passed the Department of Transportation high-speed and endurance tests. They were also found to be equivalent on winter traction tests and for road wear abrasion resistance.

Some small truck tires were built and tested in Mexico and these passed high speed performance, tire endurance, cleated wheel, and plunger energy tests.

This spring Goodyear began a small trial planting of guayule rubber at our Litchfield Park, Arizona farm. The experiment will provide valuable information about the best planting and cultivating practices for guayule. We do not plan getting into cross-breeding, genetic studies, plant physiology and similar long range programs necessary to achieve substantial advances over the guayule technology developed during and following World War II. This work is best suited for research organizations and universities equipped for this type of development.

We believe the technical qualities of purified guayule rubber make it acceptable for use as a replacement for Hevea natural rubber and synthetic natural rubber in certain formulations.

There is little doubt that if guayule was available today at a competitive price that it would find its place in the rubber market. At this time, however, the economics of guayule are not as clear as the technical qualities.

There are four major areas that contribute greatly to the final cost of the guayule rubber. These are:

1) Yield or per cent of rubber content in the shrub;

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2) Agricultural techniques to be employed;

3) Factory processing and extraction methods;

4) By-products utilization.

The area of yield improvement perhaps holds the most promise for the future.

The present sources of guayule are typically wild stands with considerable variation in yields from one plant to the next. A similar situation existed among the wild Hevea trees in the Amazon Basin before any selection and breeding had been done.

At that time, unselected seedlings would yield less than 300 pounds per acre, but today, after a relatively few generations of cross pollination, experimental clones of Hevea yield upwards of 3,000 pounds per acre.

It is possible that equally striking results can be obtained from the wild population of guayule currently found in the southwest. But with one generation a year, a much faster improvement should be realized than with Hevea.

Once a high-yielding variety of guayule is bred it can easily be propagated. As a result, guayule can be expected to reach the initial goal of at least 1,200 pounds an acre per year with little difficulty. A similar yield is considered reasonable for a Hevea plantation.

The second area, improved agriculture techniques, should be easier to accomplish but won't have as great an effect on the cost. The application of modern ideas and equipment that were unknown when guayule was grown in the 1940s and early 1950s will likely enhance planting and harvesting methods, weeding, irrigation and perhaps even fertilization techniques.

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Presently, the only guayule processing facility in the world is the Saltillo, Mexico pilot plant.

The slow and costly extraction process consists of pulping with caustic soda to remove the rubber and resin from the pulp. The resin is then removed by acetone extraction and the rubber is dissolved in hexane, with antioxidant added, before final purification.

A lot more investigation is needed into the processing of guayule rubber. There are certainly other extraction and purification methods possible that can be developed.

The final area of economic concern is by-product investigation and it is probably second to yield in influence on cost.

For every 100 pounds of polymer there is around 33 pounds of resin. If a market could be developed for the resin, this would obviously reduce the cost of guayule rubber.

The other major by-product, wood pulp, has potential in the low grade paper or cardboard industry. Another possibility is to use the pulp for its fuel value.

There are some important questions yet to be answered before commercial production of guayule can be expected.

But the results of our studies are encouraging and we are quite confident about the prospects of producing commercial products with guayule rubber. We are optimistic that additional research will lead to increased yield, improved cultivation techniques and an efficient extraction process that will make guayule a viable product and competitive with Hevea prices of the 1980s.

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To make this happen, however, a program such as that proposed by the Native Latex Commercialization Act is essential.

The success of a guayule program will depend largely on its management.

We have a perfect model in the 1942-55 synthetic rubber research program organized by government, with the help of industry and universities. A key to the success of this highly-regarded program was the centralized coordination and management, involving widespread participation by the various contractors in making recommendations that strongly influenced policy decisions.

While a guayule program won't be nearly as large or vital, it should be set up in the same manner. A single centralized management should be responsible for setting overall goals and policies and allocation of funds. This management force free from outside influence would insure the best return for each dollar invested in the development of guayule and could result in the commercialization of guayule sooner and at less expense than envisioned when the $60 million allocation was proposed in this bill.

Rubber companies should be well represented on the program's advisory council as they have the basic technology needed to evaluate the quality of guayule as it is developed.

We believe the crucial role that the finishing process plays in determining the cost, quality and uniformity of guayule merits a substantial share of the budget being allocated in the early years.

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We recognize the value of the information being provided by the Mexican pilot plant but we feel that the resources and experience they have been able to bring to the project are modest in relation to the magnitude of problems to be solved.

The experience accumulated in this country since World War II should be drawn upon in developing processes for converting guayule shrubs into rubber, including separation and evaluation of the extracted resin and other by-products.

A major portion of the money devoted to processing should be in the form of contracts with companies and R&D organizations with direct commercial experience in the appropriate fields. Any delay in doing this would, in our opinion, leave the vital question of the eventual economics of guayule unsettled far too long and could jeopardize the ultimate decision to commercialize.

There is no doubt that a domestic guayule industry would be in the national interest.

With a domestic source of guayule, we would not have to stockpile as much Hevea rubber. This reduction, of course, would depend on how quickly guayule can be commercialized. But the faster the guayule program is instituted, the less money will have to be put into implementing the very expensive rubber stockpile program.

A domestic guayule industry would also stimulate the economy in the southwest, particularly among Indian tribes.

Many questions remain to be answered about guayule but the potential is there. The enactment of H.R. 12559 would represent a giant step in realizing that potential.

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Mr. THORNTON. Thank you, Mr. Riedl. Is 35 to 40 percent the percentage of rubber typical of the percentage of natural or Hevea rubber that is in a commercial tire today?

Mr. RIEDL. In a winter tire there is more natural rubber because of its ability to hold the road than there is in a normal tire. Yes; that is typical of a winter tire.

Mr. THORNTON. Thank you. Also, I was interested in a technical problem that I think your testimony alluded to. One of the future witnesses is going to speak to it more specifically. That is the lack of an antioxidant in the rubber content of the guayule plant which affects, apparently, the way the plant is harvested, the delay time before it begins to be processed, and maybe affects the extraction process itself, with regard to when the antioxidant needs to be added in order to protect the rubber.

Do you have any observations with regard to how some of these problems might be handled? Is it going to require plant locations near the fields or some unusual method of harvesting?

Mr. RIEDL. Let me say this. Natural Hevea rubber has a natural antioxidant already in it. Guayule, for some reason, does not.

An antioxidant is necessary to preserve the rubber once it is free from the shrub and in the open air.

We have done very little work on this, but what work we have done indicates that a reasonable timelag is possible. For instance, if you were to take the shrub and hold it for months, I think that would be deleterious, but a day or two I do not believe would be harmful.

As a matter of fact, we bring shrubs from Texas to Akron. It takes a week, and we find no serious deleterious effects.

Mr. THORNTON. You mentioned the advantageous effect of a guayule industry upon our Nation's economy. I would like to know how much, in dollars, we are now importing of the natural Hevea rubber from overseas; the actual cost of the imports we are now making; and, also, what is the energy equivalent in Btu's in the synthetic rubber that guayule might replace.

Is it possible to pull together this kind of information?

If you do not have the information available now or if it is difficult for you to obtain, please let me know.

Mr. RIEDL. I believe I can answer the first part of your question.

I have just come from the International Rubber Study Group which is meeting now at the State Department.

Their estimate for 1978 is 800,000 metric tons of natural rubber being imported into the United States. Let us say that a ton of rubber today costs around $1,000—50 cents a pound—so you are talking about $800 million.

Mr. THORNTON. That is nearly $2 billion of our unfavorable balance of trade which can be related to the importation of rubber.

Mr. RIEDL. Some of that goes into freight which is returned here, but the majority—90 percent, at least—is paid overseas.

Mr. THORNTON. Approximately $800 million is reflected there.

Would it be possible for you to obtain for us the amount of synthetic rubber which is petrochemical based, I believe, in order to determine what our energy savings might be if we were able to produce guayule rubber?

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Mr. RIEDL. The United States, this year, will use around 2.4 million tons of synthetic rubber.

Mr. THORNTON. All of that could not be replaced.

Mr. RIEDL. No. That is what I was going to say.

The general purpose part of that is perhaps three-quarters. That is the general purpose rubbers, but I certainly do not want to give the impression that guayule could replace that.

The tires you would make would not be as good. In other words, an all-natural rubber tire is not as good as a blended tire.

Mr. THORNTON. Right. The synthetic is actually superior in some areas.

Mr. RIEDL. Yes; in many areas.

Mr. THORNTON. Mr. Harkin, do you have any questions?

Mr. HARKIN. No; I do not have any questions. Thank you.

I would just say that when you are from Iowa, as is the case in Ohio, I am sure, your tires go thump, thump, thump, for about 2 hours after you start off in the cold winter.

Mr. RIEDL. That is because they have nylon in them.

Mr. HARKIN. That is right. [Laughter.]

No, I have no questions; thank you very much.

Mr. THORNTON. Thank you very much, Mr. Riedl.

Our next witness is Dr. David Rubis, professor of plant sciences, University of Arizona.

Dr. Rubis, welcome to our joint hearing between the Subcommittee on Department Investigations, Oversight, and Research and the Subcommittee on Science, Research, and Technology.

We have received your prepared testimony and have reviewed it and would like to make it a part of the record, without objection.

We would like to ask you to highlight or summarize that testimony.

As you have observed, I have already mentioned the antioxidant question regarding your paper. It is a very interesting question.

Please proceed.

Mr. RUBIS. Thank you, Mr. Chairman.

Pardon me, Mr. Thornton, for addressing my paper to the Honorable George E. Brown. I did not know who was going to be chairman here.

Mr. THORNTON. That is quite all right.

George Brown is a strong member of both the Agriculture Committee and the Science and Technology Committee, and agreed to act as chairman for this afternoon's joint hearings.

I am the chairman of the Science, Research, and Technology Subcommittee.

Mr. RUBIS. Thank you very much. I do have a set of pictures of some of our activities at the University of Arizona on guayule.

If I might, I would pass them to you. If I get boring to listen to, you might look at those while I am talking. I will get to some things on those later.

Sometimes, people have not had the opportunity to see guayule in its entirety.

Mr. THORNTON. Thank you.

[The prepared statement submitted by Mr. Rubis follows:]

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Testimony concerning "Guayule"

by

Dr. David D. Rubis

Professor of Plant Sciences
University of Arizona

Honorable George E. Brown, Jr., Members of the Committee on Agriculture and Members of the Committee on Science and Technology:

I am pleased to have the opportunity to discuss guayule with you today. Guayule has a tremendous potential as a new crop, as a new domestic source of natural rubber, and a new domestic industry. It is indeed heartening to see that the House of Representatives bill H.R. 12559 specially authorizes a program of research and technological development on guayule. The implementation of this bill will come a long way in the development of guayule as a crop and guayule rubber as an industry.

My comments to you today are that of a scientist, more specifically, a plant breeder, geneticist, and an agronomist who has spent over 25 years in the research and development of new crops. There are many criteria each crop must meet before it becomes fully commercialized and reaches economic production. Over the past 25 years I have investigated 10 to 15 crops to a greater or lesser extent. As an example of these crops, safflower became fully commercialized; whereas, castorbeans were commercialized for a while but were discontinued because castor oil could be imported cheaper than it could be produced.

We might review for a moment some of the criteria a crop must meet to become fully commercialized. The crop must be produced in an adapted area in regard to soil, humidity, temperature and available moisture; there must be available good varieties with satisfactory yields, proper composition, disease and insect resistance; there must be available machinery to plant, cultivate and harvest the crop; and the crop must produce a product that has a consumer demand, of good quality and competitive with like products or not easily substituted. In addition to these, to be economically profitable, the crop must be able to compete with other crops that can be grown on the same land and the main product must be able to compete with like products in consumer use or industrial use.

In developing a new crop one determines the greatest handicap or bottleneck to economic commercialization and places top priority on solving these problems first. It may be an agronomic factor such as freezing temperatures or disease loss, or a problem in mechanization of harvest, or a product factor such as quality or composition. To solve these problems there must be close cooperation among many workers such as breeders, physiologists, engineers, chemists, and other disciplines. More often than not, several breakthroughs on such factors as yield, disease resistance, or even consumer use of the product are necessary to firmly establish a new crop.

With this perspective in mind let us look at guayule and see where it stands in becoming successfully commercialized. The area of adaptation is fairly well defined to the arid and semi-arid regions of Texas, New Mexico,

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Arizona and California. There are thousands of acres available on which agriculture has been discontinued because of the shortage of water for conventional crops. Guayule with one to three irrigations per year could initially be grown on this land and other land where water shortages are rapidly developing. At this moment variety recommendations would be very difficult to make. When guayule research was discontinued in 1959 seed of only 25 strains including the commercial variety N593 were saved at the National Seed Storage Laboratory at Fort Collins, Colorado. The variety N593 performed fairly well in California but less so as you went east into Arizona and New Mexico and poorly in Texas The other strains were mostly saved on the basis of rubber yield in California. Generally those that did well in California did poorly in Texas and vice versa and their performance in Arizona and New Mexico is not known. Therefore it will take two to three years of yield tests to determine which of the present varieties or strains would perform best in each area Planting practices during the Emergency Rubber Project (ERP) consisted of seeding in outdoor nurseries and transplanting at about eight to ten months of age. We are now propagating in the greenhouse and transplanting at about two to three months of age. Direct seeding in the field may also be possible. Considerable research will be necessary to determine the best and most economical method of plantation or field establishment. Previous research has shown that factors such as temperature, soil moisture, seasonal periods of moisture stress, light intensity and nitrogen supply and their various interactions had effects on rubber accumulation. More physiological research is needed on these factors as a guide to determining the best agronomic production practices. During the ERP special equipment was built and other machinery was modified to harvest seed, thresh seed, transplant seedlings, harvest plants, etc. A special project for the designing and building of necessary machinery is needed now. During the ERP the entire plant was dug at about four to five years of age. There are options of pollarding or digging and at different ages. More research is needed to determine the most economical procedure. Guayule rubber has a lack of antioxidants so that the rubber begins to oxidize and degrade once the plants are killed or harvested The method of harves ing, the distance to the processing plant, and the processing procedures could affect the quality of the rubber Research is needed in harvesting practices, and in transportation and storage of the shrubs In the processing of guayule for the extraction of rubber there are questions as to whether the resins should be taken out at the start of the process or at the end of the process as is now done at the pilot plant at Saltillo Mexico. Research on rubber extraction is needed so as to obtain rubber quality as well as ef iciency of production. Research is also needed on the extraction of the by-products, especially resins and bagasse and on their successful utilization.

My remarks above by no means cover all the necessary research on guayule, but it is quite evident that guayule is <u>not</u> now ready for economic commercialization. The implementation of a Congressional guayule bill, with the provisions as in H.R. 12559 could provide the necessary research and development over the next four or five years to make guayule economically feasible. Data from such research will also provide information to determine the economic feasibility of guayule in different areas.

Although guayule production is not presently <u>economically</u> feasible, I believe that guayule production is very feasible and should commence immediately on a limited-acreage basis because of the vital importance to the

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economy, defense, and well-being of the nation. Guayule production is feasible because seed resources are available, the knowledge of growing the plant is available and the quality of natural rubber from guayule can be substituted for natural rubber from Hevea. It is very doubtful that it could be competitive with Hevea rubber and would need to be subsidized. A planned program of planting 4 000 5 000 acres a year for the next four or five years with the construction of an extraction plant the third year would be a modest but reasonable program The management of such a program should be in close cooperation with the personnel doing the research. The vital importance of an immediate program is several fold, but I would like to emphasize three of them. First of all, the United States is completely dependent on foreign sources for natural rubber and the importing of natural rubber helps create the large deficit in the balance of payments and increases inflation for all of us. Secondly from the standpoint of strategic materials the stockpile goal for the Federal Preparedness Administration and Department of Defense is over 500,000 tons and the present stockpile is less than a quarter of this In time of national emergency natural rubber will be critical both for direct military use and for industrial mobiization for na ional defense Thirdly, guayule produces hydrocarbon directly and is a biosolar renewable resource which can replace petroleum-derived polyisoprene rubbers and is therefore an important renewable energy resource.

As a plant breeder I am very excited about the potential possibilities of guayule on a long term basis like 10 to 15 years. I have no doubt of guayule becoming an established economic crop. Because of the genetic makeup of guayule and its crossability to a number of related Parthenium species there is an unlimited number of possibilities of architecting a guayule plant with many different desirable characteristics. For example, we can cross with the tree-like stramonium and produce faster growing guayule. Most of the present strains of guayule are plant selections from the wild so that a concentrated crossing and selection program should have good possibilities of increasing rubber percentage.

A good research program on guayule can be very important to our energy program because guayule can serve as a model plant for biosolar production of hydrocarbons. Many plant scientists believe that a large part of our solution to the energy problem in the future will be the production of hydrocarbons by plants. For example, we will use the plant to produce seed for food and the rest of the plant will be processed for hydrocarbons. Guayule is a very profuse seed producer and produces up to 15 to 20 percent hydrocarbons The study of the formation and measurement of hydrocarbons in guayule should help to develop techniques of measuring and increasing hydrocarbons in other plant species.

I would like to review very briefly the status of guayule research in progress today As a result of the guayule conference in Tucson in 1975 and the recommendations of the panel of the National Academy of Sciences we started research on guayule at the University of Arizona in early 1976. We formed a "University Guayule Group" of a number of disciplines across departments and across colleges. I had the unique opportunity of being appointed chairman of this group. We drew up a comprehensive plan of research and development to develop guayule as a crop. In 1976 we obtained a grant from the National Science Foundation to collect germplasm and start a breeding

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program. We have a good start in collecting germplasm of guayule and related species from Mexico having collected 115 major collections in 1976 and 40 more in 1977. We have established a germplasm nursery and are functioning as a germplasm center to furnish seeds to other workers. In 1977 we obtained a grant from the Four-Corner Regional Commission for research and development of guayule in Arizona, New Mexico and Nevada. With the Four-Corner grant we have been able to expand the guayule research so that besides the germplasm and breeding projects work has begun with plant diseases machinery and equipment development, rubber analyses and the development of an information center This fall work will begin in physiological studies and irrigation and fertilizers Under the Four-Corners grant there is weed control and breeding research being conducted at New Mexico and observation nurseries in Nevada. One of the major accomplishments of the past six months was increasing seed of the 25 strains from the National Seed Laboratory for establishing yield tests. Enough seed was increased to furnish seed for four locations in Arizona, three in New Mexico, two in Nevada and one each at the Los Angeles Arboretum and Texas A & M University Station at El Paso, Texas. In Arizona we planted yield tests during April and May at Yuma, Mesa, Tucson and Goodyear Farms at Litchfield.

Besides the Four-Corner Regional Commission research in Arizona, New Mexico and Nevada there is the group at Los Angeles Arboretum funded by National Science Foundation, Texas A & M group at El Paso, Texas funded by the Southwest Border Regional Commission, and the U.S.D.A. Laboratory at Pasadena, as the major guayule research on plant development Goodyear and Firestone have also started work Research in rubber chemistry and extraction is in progress at the University of Akron and in the private laboratories of Goodyear, Firestone and Goodrich. There may be others involved, but these groups named above all participated in a guayule workshop in Tucson last January and are cooperating in the guayule research.

Now for some recommendations for the improvement of H.R. 12559. My main recommendation would be to provide for the establishment of a Central Coordinating Office for the research and development and the establishment of a National Advisory Committee. This is in agreement with the recommendations of the panel of the National Academy of Science. A central coordinating office would help coordinate research among the many disciplines among the various institutional groups, and among the states and Federal agencies involved. A central office would also monitor all the research so as to determine that proper emphasis is given to the various problems according to research priorities Such a central office should also provide leadership and cooperation and help to provide an exchange of materials and ideas among the many projects.

The bill provides for coordination of activities of the various Federal Agencies in Section 10, but does not provide for an Advisory Committee as such. The Senate bill S. 1816 was amended to provide for a National Advisory Committee made up of representatives from the Department of Agriculture, Department of Interior, Federal Cochairman of the two regional commissions National Science Foundation, National Academy of Science and one representative of the private sector. The National Academy of Science panel recommended an advisory

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committee made up of outstanding scientists and administrators from industry, government and academic institutions. I believe there should be a National Advisory committee which would include representatives from Federal Agencies, rubber industries, and research institutions. It should include both scientists and administrators from all sectors.

Thank you for the opportunity to provide testimony on a subject that is so important to the Southwest and to the well-being of the nation.

David D. Rubis

(Biographical Sketch)

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Born: Jackson, Minn. May 30, 1924

Degrees:

B.S.	Univ. of Minn.	1948
M.S.	Iowa St. Univ.	1950
Ph.D.	Iowa St. Univ.	1954

Present Status: Professor of Plant Sciences, Univ. of Arizona since 1956
Teaches plant breeding and genetics courses.
Advisor to graduate students
Research on development of new crops.

Special Research Achievements:

Developed safflower as a crop in Irrigated Southwest including numerous varieties.
Development of plantago as a crop for Arizona including numerous varieties
Development of shatter-resistant soybeans (making possible soybean production in low humidity desert areas)
Numerous scientific publications

Professional Societies:

American Society of Agronomy
Crop Science Society of America
American Genetic Association
Genetics Society of America

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Mr. THORNTON. Thank you very much, Dr. Rubis.

In comparison with the source of rubber from a tree where the rubber is harvested, I believe, in the form of a resinous liquid, what is the source of the rubber in the guayule plant? Is it spread throughout the plant? The reason I am asking you is that you mentioned the roots. Is some of the rubber found in the roots?

Mr. RUBIS. The rubber in the guayule is in the form of rubber as the plant grows and is scattered throughout the plant in older tissue as well as new tissue in individual cells. It is in the branches, in the main stem, and also in the roots.

There is a latex, as such, before it gets laid down. The part of the word, "gua," refers to bark—an Indian term. "Hule" is actually Spanish for rubber. It is the rubber from the bark.

Mr. THORNTON. You harvest the rubber from throughout the plant. Is that correct?

Mr. RUBIS. Yes. You harvest the entire plant. It is ground up in a hammermill, and the rubber has to come out from the individual cells. They probably use something like lye or sodium hydroxide to break up the fibers and release the rubber.

Mr. THORNTON. You mentioned the lack of an antioxidant in your paper. Is this genetically curable? Is it possible to selectively breed to find a way of having an antioxidant present in this rubber?

Mr. RUBIS. Anything is possible in genetics. Whether or not it is probable or whether it is there or not, we will have to see.

Mr. THORNTON. What I am asking is whether there have been any mutations or variations that contain an antioxidant?

Mr. RUBIS. Not that I know of.

We had this same problem in safflower of an antioxidant in the polyunsaturated oils. Industry said, "We can add an antioxidant so cheaply that we would rather you spent your time finding something else."

Of course. I think it is always good to look at it because when you do find it, that is the cheapest way.

Mr. THORNTON. What is the storage time for the harvested plant before you begin to have a serious degradation?

Mr. RUBIS. I do not know the answer to that question.

I know that some of the plants in Mexico during the Emergency Rubber Project were stored as long as 6 months. Mr. Taylor mentioned to me that he thought this may have had some degradation to the rubber, and we should be looking at it in a laboratory. The reports were that if they ground the sample for rubber analysis, once it was ground up, and they did not refrigerate overnight, the rubber was degraded by standing out in room temperature rather than in a refrigerator.

That is the most data I know of. The reaction is there, but to what extent we do not know. At least, I do not know. Maybe someone else does.

Mr. THORNTON. This plant produces a resinous hydrocarbon which can be processed into rubber. Is the property of producing liquid or resinous hydrocarbons something that is shared by a large number of plants?

Mr. RUBIS. In the last 2 weeks I have been talking to other plant scientists, and there seems to be a lack of knowledge on this. There was a paper put out in 1975, or sometime like that, by Peoria Laboratory, USDA, in which they listed just about all our farm crops. They

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had percentages, like 3 and 4 percent hydrocarbons, in the various plants.

I think that we have not looked at this particular characteristic. When you had composition of plants, there was always that 3 or 4 or 5 percent of something else, and that was all we ever put down because we were not interested. Right now, there is a disagreement among scientists as to what we are looking for.

In fact, if you talk to someone like Melvin Calvin in Berkeley, he says we should be looking at plants for the hydrocarbon characteristics for energy. I know the Energy Department right now is putting out proposals where they are having a lot of species looked at for BTU. I think it is wrong. I think they should be looking for hydrocarbons.

So, we are standing in the midst of a lot of things we should know about but do not know about as regards energy. We just have not studied this before.

Mr. THORNTON. Brazil has a strong program of utilization of sugarcane.

Mr. RUBIS. Yes; they go into ethanol. From there, it would be the same way as industry would go for petroleum. They go to ethanol or methanol, or whatever, and go to a lot of products. If you can have some hydrocarbon directly, then you do not lose the energy in changing it.

Mr. THORNTON. That is right. You make the plant do the work for you.

Mr. RUBIS. The energy comes directly from the sun and is changed into usable energy.

Mr. THORNTON. That is right.

I want to thank you for your very excellent presentation, Dr. Rubis.

Our next witness is Mr. Hugh Anderson, who is president of the Pacific Rubber Growers Association.

Mr. Anderson, welcome to the joint hearing of our two subcommittees on this very important legislation which has been introduced by Mr. Brown of California.

We have received your prepared testimony for the record.

[The prepared statement submitted by Mr. Anderson follows:]

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HUGH H. ANDERSON Testimony, June 19, 1978

RE: H.R. 12559

Chairman Brown and distinguished members of the committee:

In view of escalating costs of synthetic rubber and the growing shortage of natural tree rubber the question that repeatedly is asked is "Why is the country not already growing GUAYULE rubber?"

Is it lack of basic knowledge regarding growing GUAYULE? No. During World War II our government undertook a crash program in California and employed thousands of scientists, agronomists and agricultural workers to develop standardized seeds, nursery techniques and field and harvesting programs. At one time the government had over 35,000 acres of GUAYULE growing.

Is it lack of processing knowledge? No. The U. S. Government produced 2,947,273 pounds of GUAYULE rubber from 1942 to 1945.

Is it that the knowledge of producing and processing GUAYULE has become a forgotton art? No. Pacific Rubber Growers has been ready, willing, and able for over 30 years to grow high quality natural Parthenium rubber from the GUAYULE shrub.

Is it that when the government, at the end of the war in 1945 destroyed the very considerable GUAYULE stand that all of the standardized seed was also destroyed? No. Pacific Rubber Growers rescued the standardized GUAYULE seed.

Is it necessary to repeat the work done during World War II as a preliminary to successful large scale planting today? No. Pacific Rubber Growers has not only the old knowledge but has subsequently made many improvements in the growing and processing of GUAYULE and is able to produce a final product that is greatly superior to the World War II GUAYULE rubber.

So again we are faced with the question "Why is this country not growing GUAYULE rubber?" Perhaps the answer may be clarified with a brief review of GUAYULE during this century.

The Intercontinental (GUAYULE) Rubber Company, founded by Bernard Baruch, Rockefeller and others in 1903, achieved tensiles in their GUAYULE rubber of about 3000 pounds per square inch. The highest record achieved with GUAYULE by the Emergency Rubber Project under the U. S. Department of Agriculture was 3700 pounds per square inch. In 1946 Pacific Rubber Growers' GUAYULE rubber was tested by the U. S. Rubber Co. (Uniroyal) at 5200 pounds per square inch. The highest tree rubber at that time had been tested at only 4800 pounds per square inch.

In 1930 Dwight Eisenhower submitted a "Report of Inspection of the GUAYULE Rubber Industry" in which he made the following observations of the need for GUAYULE:

1. Domestic rubber supply in case of dire emergency to eliminate dependency on southeast Asia.
2. Domestic supply for price protection against possible commercial combines by rubber producing countries in the far East.
3. Industrial development to provide profitable employment for Americans.

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4. Improved utilization of agricultural acreages currently devoted to crops of which we produce surpluses (Corn, cotton, grain).
5. Utilization of semi arid areas in southwest U. S. where GUAYULE is indigenous.
6. A supply of natural rubber by cultivated GUAYULE would mean much lower prices for the remaining required rubber.

Eisenhower continued: "We are personally convinced that under real encouragement the production of GUAYULE rubber would develop rapidly into an important industry in the United States. We further believe that an offer of the U. S. Government to purchase all rubber raised and milled within the continental limits of the U. S. at a price based on standard smoked sheets of hevea rubber would certainly furnish this stimulus."

Since World War II Pacific Rubber Growers has been the major voice, usually the only one, advocating GUAYULE and has been the only company that has continued to work on improvement of growing and processing techniques.

During President Eisenhower's term of office, we had papers on his desk indicating the feasibility of producing our Parthenium rubber. His referral of our data to the Department of Agriculture brought a negative response indicating a more favorable position for snythetic rubber and its long term availability than was justified.

Pacific Rubber Growers furnished encouragement and data to the Mexican government which assisted them in their current successful laboratory processing wild GUAYULE shrub in northern Mexico. Through our encouragement and assistance, the Los Angeles County Arboretum has been able to obtain a grant from the National Science Foundation and is working on GUAYULE seed improvement. Seed improvement means increasing the per acre yield possibly twenty fold in the coming years, according to the opinion of Dr. Reed Rollins of Harvard University. We have aided the University of California in obtaining material for their examination of GUAYULE under the electron microscope.

We are well aware of the value of research and have several proposals to make ourselves in research projects, however, we know that we are now able to produce rubber that will be classified among the best rubber in industry at competitive prices. It might be noteworthy to be specific on the value of time at this point. Why shouldn't we start now in preparation for field planting rather than a year from now? The history of the past few weeks will show a rise in the world price of natural rubber from 44¢ to the current 48½¢. This can be translated to a rise in the market cost of rubber of $45,000. dollars for each 500 tons. In other words it has added $90,000. dollars to the cost of one thousand tons. The U. S. will probably buy upwards of 60,000 tons this month for an annual added cost of over $60 million dollars.

We have met with representatives of the Department of Agriculture on two occasions during the past ten years meeting with complete lack of cooperation. We are very pleased that the present attitude of the Department of Agriculture is entirely positive under this new administration in the interest of developing Parthenium rubber.

Pacific Rubber Growers is in the fortunate state of having adequate proven viable seed for planting upwards of 10,000 acres. We are, of course, having heavy demands on us for this seed from all over the world, demands that we have resisted in the interest of our own

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domestic rubber program.

We have a new extraction process which was tested by the government and found to require but 1/14 or 7% of the power to recover 99% of the rubber in the shrub. The previous process only recovered 65% of the rubber.

We have already indicated the high quality of our rubber but we should further refer to statements by representatives of the government that the resins from Guayule will produce industrial chemicals that have a value equal to that of the rubber. The bagasse, after the rubber and resins are removed, can be used in the manufacture of high grade kraft paper which has been approved by Crown Zellerbach Paper Co., and it is widely known that the wax obtained from the leaves of the GUAYULE plant is of high quality and consequently high priced.

We have friends, both in government and in private industry, who are eager to work with us in helping to establish a new industry in the southwest United States that will favor the country by saving foreign exchange, adding to domestic employment, providing a new agricultural crop that requires less water than other agricultural crops and giving us protection both in price and in the event of conflict, should such ever again arise.

We recommend in view of our immediate ability to proceed, the rising cost of rubber due to the on coming shortage, the predicted shortage of paper pulp and for the general economy of the nation, immediate funding on a basis that will allow us as private operators to do a demonstration planting program on a minimum of 10,000 acres which would support an economical extraction mill. As soon as we have planted 5,000 acres, there will be seed available for others at a price that will be much lower than any seed available. We would also like to participate in a number of research projects which will further enhance the industry towards greater economy in the cost of the rubber. We ask for a beginning allotment to be made available over three years of $15 million subject to the influence of inflation and other uncontrolled factors.

We suggest as an expediency for rapid funding that it be written into the law that bank loans will be guaranteed for initial and early funding for planting but direct grants be given for additional research. If Pacific Rubber Growers is allowed to fulfill its ambition of 35 years to help establish a domestic rubber program in the U. S. with all of its benefits, we shall be grateful for the opportunity to this committee and to those in the government who have effective ability to be helpful.

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HUGH HARRIS ANDERSON, President, PACIFIC RUBBER GROWERS

Native of Pasadena, California. Graduated from Stanford University with degree in economics. Licensed accountant.

Commenced career as fiscal agent for National Youth Administration in California, later served as field auditor for the State of California for five years.

During 1942–45 worked closely with U. S. Department of Agriculture Emergency Rubber Project, particularly Major Evan Kelley, Director, who left Mr. Anderson his personal library.

1946 Founded Desert Rubber Company and served as President. Designed and constructed a rubber extraction mill producing rubber superior to that achieved by others on 1150 acres of Guayule.

1964 Formed Pacific Rubber Growers and renewed activities to further a domestic rubber program, serving continuously as President. Constructed laboratory, obtained wild shrub from Mexico, and extracted rubber from Guayule. Tests by five local companies, including Uniroyal confirmed rubber tested superior to available tree rubber.

Instrumental in encouraging Guayule development in articles and by furnishing data and assistance to Arid Zones Commission (Saltillo, Coahuila, Mexico), Los Angeles County Arboretum and University of California

Appointed Consumer Counsel for Southern California to Governor of California in 1964.

Served on Board as Treasurer to Pacificulture Asia Museum and Foundation in Pasadena and Treasurer for World Committee for a World Constitutional Government.

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Mr. ANDERSON. In summary, there is an impending shortage of natural rubber. Imported and synthetic rubber is becoming increasingly expensive. Guayule is equal to tree rubber but less expensive to produce. Pacific Rubber Growers has standardized seed and knowledge to immediately start large-scale planting and processing of guayule rubber.

Therefore, we recommend that H.R. 12559 include a provision to guarantee bank loans to rubber growers for immediate guayule planting and processing. This would result in a saving of the economy in excess of the entire cost of the bill.

Thank you for your thoughtful participation and consideration of what I have to say.

Mr. THORNTON. Thank you very much, Mr. Anderson.

What is the yield approximately of the seed stock which your company has available?

Mr. ANDERSON. The yield varies according to conditions under which it is grown. Our seed has had a maximum of 1,000 pounds per acre per year over a 4-year period.

Mr. THORNTON. With regard to further improvement, one of the things that our subcommittees must look at as we consider this bill is the allocation of funds between research and development—trying to improve yield and how better to process, et cetera, as compared with the commercialization potential of the guayule source of rubber.

Your testimony seems to indicate that we can move rather rapidly into commercialization. Is that correct?

Mr. ANDERSON. We are thoroughly convinced of this—yes.

Mr. THORNTON. How would you address the problems which have been referred to by other witnesses of the need to develop strains of plant which are more frost- or cold-resistant, the need to have an additional water supply in order to provide for irrigation, and those sort of problems?

Mr. ANDERSON. In the first place, the seed we have has been proven. Thirty-five thousand acres of it were growing in California. Undoubtedly, if we wanted to move north, as the Russians are doing, we would have some trouble in the cold areas north of the 35 or 40 degree parallel—in San Francisco, Calif., for instance.

I might suggest that these seeds had twice the yield in Australia than they had in Salinas when they were growing for the same length of time.

Mr. THORNTON. Is there any reason for that?

Mr. ANDERSON. I do not know what the reason would be. I am not enough of an agriculturalist. My associates who are better detailed could give answers to that.

We can only go by the past experience of growing this seed. We know that the seed was not used beneficially during the war because it was planted on soil which had too much moisture in it.

As you probably know, the production of rubber is the result both of developing the vegetative size of the plant plus increasing the percentage of rubber in the plant. My 1,150 acres of guayule happened to be the best looking plants in the State, planted on land that had a high water retention. As a result, there was no real stress to the plant. Guayule requires stress during the year to produce rubber and raise the rubber percentage.

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These two factors have to always be considered in producing maximum rubber per acre.

Mr. THORNTON. Let me understand exactly what you have just said.

Did you say that the proportion of rubber in the plant was dependent on the stress?

Mr. ANDERSON. The percentage of the rubber in the plant is dependent on the stress that the plant is subjected to.

For instance, the ideal situation would be to put the water on the plant rather heavily in the spring, force the vegetative growth and get as big a plant as possible, and then let it suffer—put it under stress for the rest of the year. At that time, it is working on rubber accumulation. Next spring, put on the water again.

Mr. THORNTON. Your method of growing and harvesting is to use the entire plant. Is that correct?

Mr. ANDERSON. Yes. We replace on a preferably 4-year harvest cycle. In other words, 2,500 acres would be harvested for the factory each year, so that there would be a continuous operation of the mill.

Mr. THORNTON. Are you saying that you would harvest 4-year-old plants?

Mr. ANDERSON. That is correct. And 10,000 acres produces the 2,500 acre result. That is about a minimum amount of rubber to make the mill economically effective. We can put up laboratory mills, of course, and get out rubber, but not on an economic basis.

Mr. THORNTON. I want to again express my own personal appreciation to my colleague, the Honorable George Brown, of California, for introducing this legislation which has become the subject matter of these hearings, and I would like to express my appreciation to each of the witnesses who have appeared today and given testimony.

There being nothing further, this hearing is now adjourned.

[Whereupon, at 3:20 p.m., the hearing was adjourned.]

[The extraneous material submitted to the committee follows:]

STATEMENT OF LESLIE E. BAIRD, FREELANCE TECHNICAL WRITER, GOLETA, CALIF.

This opportunity to contribute to a Congressional hearing on guayule the plant, and guayule the natural rubber, is fortuitous because during the years of my study of guayule, I saw that it had a practical future and now the time seems to have arrived when the North American native natural rubber shrub will again become a useful material in our economic life.

There exists a vast storehouse of historical and scientific information on guayule which botanists know as *Parthenium argentatum* Grey, but little material on guayule rubber after it has been laid down on the receiving docks of rubber factories. Such end-product research has been resumed of late, but we must first produce the rubber. We must grow it, harvest, and before that collect and segregate the seed, and, at the same time busy ourselves with breeding higher rubber increments per plant and also try to extend its potential areas of cultivation where minimum temperatures fall below 15° F.

Guayule meets the new environmental and ecological drive for solar-grown, renewable raw materials. It is obvious, yet a truism, that our source of natural rubber, hevea, besides having to be transported thousands of miles from Southeast Asia and other lands, exist under the veiled threats of cartel action, native insurrection, and the dread leaf-blight spores. In spite of the increasing productivity of hevea plantations, their scope is not unlimited and the oil palm has become a competitor for the cropland. On the synthetic rubber side, we are all familiar with the drastic OPEC action that skyrocketed petroleum prices, and the fact that burgeoning needs for oil are hard on the heels of the discovery of new oil fields.

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The re-establishment of guayule as an industrial farm crop in the U.S. assures more farm employment on land unsuitable for water intensive food crops from California to Texas. The perennial hazards of drought are unknown to guayule.

We already have two relatively small plant-breeding projects under way which are funded by government and state agencies. This is necessary to assure higher productivity per plant. But genetic research takes time. Seed collections must be made (mostly in Mexico) before work can proceed.

The most hopeful and entirely new approach to increasing the rubber increment in the guayule shrub is being made in Pasadena (Calif.) at the Fruit and Vegetable Chemistry Laboratory. Here, a new type of bioinductive spray is being developed that promises to increase the rubber several times. We must, however, keep our fingers crossed until we learn whether it is successful after field experiments and commercial production.

Thus, if we can be certain that a minimum of 1000 lbs/acre per year can be achieved and this production also increased to 200 lbs/acre by the new spray, we have a potential on the outside of 8000 lbs/acre over the normal 4-year growing cycle, there is no doubt of guayule's economic feasibility in the near future.

On top of this production goal, we must not forget the value of the byproducts obtained from guayule after milling and deresination. Since guayule contains from 15 to 26 percent resin and, in order to remove this resin to bring the rubber up to the quality levels of hevea, the resin fractions must be removed by such solvents as acetone. Considerable research still needs to be done on this score. Other byproducts such as the bagasse can be used as fuel or for paper manufacture. Even the guayule plant leaves have a use.

So much has been accomplished over the years in all phases of guayule's agrarian methods as well as the technological improvements since guayule was put on the shelf in the 1950's that we can expect much greater efficiencies in each step of production. These advantages may well offset the inflationary prices that have come about during the intervening years.

Discounting worldwide depression, I expect that the price of natural rubber will not go below the present range of 40¢ to 47¢/lb.

Lastly, we cannot ignore the human factors involved in a new guayule program. Two conferences on guayule, one held in Tucson in 1975 and another in Saltillo, Mexico in 1977, brought together many of the surviving old guayuleros, i.e., experienced scientists and technicians who know guayule. But their ranks are thinning; most of them are retired; their usefulness is not over.

These members of the guayule fraternity should be recruited into advisory cadres in every segment of guayule production. The renewal of interest on the part of the rubber manufacturers can lead to the development of methodology and techniques of rubber product production. After all, the new efforts are for their primary benefit.

A well integrated program will put us on our way to new agricultural activity and reduce our dependence on foreign imports of natural rubber, a financial as well as a strategic benefit.

STATEMENT OF JACOBS ENGINEERING GROUP, PASADENA, CALIF.

Jacobs Engineering is pleased to present testimony before this committee and appreciates the opportunity to do so. We are an international engineering-construction firm serving the chemical process industries on a world-wide basis since 1947. We are active in process development and the engineering, design and construction of process plants involving natural materials such as Guayule Rubber. We provide professional engineering design, construction and related technical consulting services to clients throughout the world.

Our company became aware of Guayule as a source of natural rubber for the North American continent in 1972, and have observed developments in this field since that time. We have reviewed technical literature on the processing of Guayule describing research efforts done in the past and are aware of work currently underway at the pilot plant in Saltillo, Mexico.

It is our belief that Guayule should be further investigated as a potential source of natural rubber in this country and that by-products from Guayule processing operations likewise be studied for development into useful commercial products. We also believe that advances in chemical processing and manufacturing technology which have occurred in recent years can be applied to the processing of Guayule, eventually leading to reduced processing time and costs as well as improving the quality of the final material.

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STATEMENT OF GEORGE P. HANSON, SENIOR BIOLOGIST AND PRINCIPAL INVESTIGATOR, NATIONAL SCIENCE FOUNDATION SUPPORTED GRANTS ON BREEDING IMPROVEMENT OF RUBBER YIELD IN GUAYULE AND CHEMICAL STIMULATION OF RUBBER SYNTHESIS IN GUAYULE

For reasons already given by Dr. W. G. McGinnies, Dr. David D. Rubis, Mr. J. J. Riedl and others I also support H.R. 12559 for research and technological development of guayule. In my opinion it is not now possible to grow guayule for a profit but research breakthroughs in a few areas could reverse this situation. I will enumerate a few of these areas to illustrate the need for research and development to begin now on this important, potential crop.

We believe that a yield of 700 pounds of rubber per acre per year can be attained under known cultural practices. This yield, however, is believed to be commercially unprofitable. A yield of 800 pounds of rubber per acre per year has been calculated by scientists as the break even point. A yield of 1000-1200 pounds of rubber per acre per year is considered by some commercial interests as sufficient for an acceptable profit. Based upon the knowledge of plant breeders with experience in domesticating wild plants, it should be readily possible to double the yield of the still relatively undomesticated guayule plant. This doubling of yield would easily place the commercial growth of this plant in the realm of industrial feasibility. At this time we do not know how long it will take to develop lines which yield 1000–1200 pounds of rubber per acre per year but with sufficient research yield increases of 5 percent per generation seem theoretically possible making the goal potentially attainable in 10 years.

Another means of achieving higher yields is suggested by the current research of Dr. Henry Yokoyama in which chemical stimulation of rubber synthesis in guayule has been demonstrated. Research of this type could very well lead to the achievement of 1000–1200 pounds of rubber per acre per year with currently available guayule varieties.

One reason for the necessary yield of 1000–1200 pounds of rubber per acre per year is the projected high costs of production of the guayule plants and the extraction of the resulting rubber from the shrub. Two means by which costs could be dramatically reduced involve cutting the expenses of stand establishment. Currently seedlings must be grown in the greenhouse and/or nursery before they are transplanted to the field. The genetic selection of guayule varieties which were adaptable to direct seeding and the development of a seed pelletizing procedure could result in a much reduced stand establishment cost.

Another means of reducing stand establishment costs is to modify harvesting procedures. During the 1940's the plant was harvested by digging which destroyed the roots. It should be possible to harvest by mowing or cutting at or near ground level so as to leave intact the root system and thereby allow the plants to rejuvenate themselves providing a new crop without expensive stand reestablishment procedures. Development of these new methods will require research into the selection and breeding of varieties of guayule that will perform under such harvesting procedures. Research will also be necessary to determine the optional field conditions necessary to stimulate rejuvenation of harvested plants.

Guayule is known to have several potentially valuable byproducts which remain after rubber extraction. The wood has been shown to make acceptable pulp for manufacture of paper and cardboard. There are also large amounts of resinous hydrocarbons present in the plant which if fully exploited could result in the production of these valuable compounds by the chemical industry reducing our dependence on petroleum sources. Again, research is necessary.

Test plots need to be established throughout the potential guayule growing area to select the best adapted varieties and to work out growing procedures on a larger scale. Shrubs from these test plots could then be used to work out extraction procedures on a commercial scale. It is necessary to develop an efficient and relatively inexpensive procedure to extract the rubber from the shrub. This procedure must yield a high quality and uniform product.

All of the above research requires money but most of the projects are relatively short term and should yield positive results within a few years. Furthermore, it is only necessary for one or two of the projects to be successful for guayule to become an economically feasible commercial crop. Research and development support is needed now if the United States of America is to become at least partially self-sufficient in rubber and before expected shortages develop in the 1980's.

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Statement in Support of H.R. 12559,
Native Latex (Guayule) Commercialization Act of 1977

by
W.G. McGinnies, Director Emeritus
Office of Arid Lands Studies
University of Arizona

and
Formerly in Charge of Surveys and Investigations,
World War II Emergency Rubber Project

I believe that a strong guayule research program is needed because: 1) a shortage of natural rubber is projected for the near future and the need for additional related rubber supplies is increasing; 2) guayule is a proven source of rubber that can be grown in the Southwest United States; and 3) it is poor policy to rely on rubber supplies from Hevea, a single plant species that is subject to disease, subject to increasing labor costs, and a natural candidate for cartel control or wartime restrictions.

The January 1978 issue of Rubber World predicts that between 1980 and 1985 the annual world supply of Hevea rubber is expected to increase by only 3.8 percent. At the same time the world's rubber product requirements are expected to increase 5.9 percent annually. The supply-demand disparity will be more than 2 percent annually. Other predictions indicate that shortages began in 1977.

Guayule was identified as a rubber producing plant

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more than a century ago and has been a source of limited supplies since the turn of the century. In 1910 half of all rubber used in the United States came from Mexican guayule. Although our total consumption at present is many times what it was then, it is still significant that the native guayule plant was capable of supplying an appreciable amount of rubber.

Faced with dwindling rubber supplies during World War II the Emergency Rubber Project established by Congress produced three million pounds of rubber in spite of the early curtailment of the project and the wanton destruction of 27,000 acres of the rubber producing shrub along with an estimated 21 million pounds of rubber. Under the Emergency Rubber Project, 500,000 acres of guayule previously authorized by Congress having a potential yield of 500 pounds of rubber per acre could have produced an estimated 1.25 million pounds of rubber, enough to meet national needs. The project was abandoned because synthetic rubbers had been oversold and lobbyists convinced the Congress that there would never be a need for a domestic supply of natural rubber. So persuasive were the advocates of synthetic rubber they not only caused Congress to order the destruction of established guayule plantations but valuable seed stocks were sold or given away and research funds wiped out also. As a result guayule became a lost resource.

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In the postwar period the makers of synthetic rubbers, and the tropical rubber growers, mostly in Malaysia, prospered. Few considered the possible advantage of having another source of rubber. In spite of all the postwar advances, including a ten-fold increase in Hevea rubber production per acre and the proliferation of synthetic rubbers, it became apparent that available rubber supplies could not meet all tire manufacturing demands because the synthetic rubbers did not have the qualities essential to tire manufacture. Radial belted tires require 25-35 percent natural rubber, truck tires up to 40 percent and airplane tires 90 percent natural rubber. And even with increases in Hevea rubber production the needs for natural rubber have become greater than the supplies.

There seems little likelihood that a synthetic substitute for natural polyisoprene rubber will be developed, especially in the face of ever-dwindling fossil petrochemical supplies. But even if a satisfactory substitute for natural rubber could be produced there would still be demand for guayule rubber on a price-competitive basis and as a renewable resource to ease the drain of fossil fuel supplies.

Guayule has many favorable qualities. It can produce a rubber essentially equal in quality to Hevea rubber as has been demonstrated by rubber produced at a pilot plant in Saltillo, Coahuila, Mexico. Guayule can be

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grown under climate and soil conditions unfavorable for food crop production; it does well on lands now producing cotton and could help solve the problem of cotton over-production; and it can be grown with less water than most other crops cultivated under irrigation, hence it can be grown where water supplies have been reduced by overuse. Also guayule can be grown under rainfall farming in areas where periodic droughts result in crop failure, but guayule could survive drought, however with reduced growth, pending the return of more favorable growing conditions.

At present guayule is at the outer edge as a cultivated crop. Using seed supplies available it could be produced at a profit under the most favorable conditions. I disagree with the conclusion expressed in the National Academy of Science report, Guayule an Alternate Source of Rubber. The authors of this report had no scientific basis for concluding that guayule could not be a commercially viable crop today (Conclusion 3). No economic studies have been made since the World War II era, but using the results obtained at that time and making allowances for the much higher costs today, it may well be that guayule rubber can be produced economically at costs within the projected price range for natural rubber (World War II estimated costs per pound of rubber, including milling, range from 12 to 23 cents under irrigation and 18 to 27 cents in terms of 1945 dollars under rainfall farming.)

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Although there is no question that a great amount of research is needed, it is also true that we have a firm starting base. Twenty-five new guayule varieties were developed during and after World War II. These varieties never were commercially produced. At least 20 varieties are superior in rubber production to strain 593 that was the standard crop during World War II and which could produce at least 500 pounds of rubber per acre annually.

With the seed supplies now available we can and must move forward as rapidly as possible to establish test plots. Field plantations should be established as rapidly as warranted by test-plot results.

This proposed planting program does not in any way reduce the need for research. On the contrary, it is a means of accelerating research because guayule plantations are necessary for studies on establishment of guayule stands, field culture, irrigation, increasing rubber content percentage, harvesting, and milling.

As discussed in the National Academy report (Recommendation 1, p. 11 and 12, and Recommendation 4, p. 14 and 15), a comprehensive and well-coordinated research program is needed to solve the somewhat complicated and widely interacting facets of guayule research. We urgently need sufficient funding to telescope research into a few years to accomplish developments such as have been made by research or domestic crops during the past hundreds of years. Guayule may be compared with corn before the development of hybrid varieties. The ultimate guayule

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potential lies in hybrids, and research is needed to develop these strains. Biologically there is a capability to greatly increase economic returns.

Economic returns depend not only on increasing rubber production per plant and per acre but also in decreasing production costs with efficiencies in planting, growing, harvesting, and milling, and decreasing disease losses. All involve research, and because of the interrelationships between the factors involved, necessitate research on all phases simultaneously--breeding and selection to increase growth, rubber percentage and disease resistance, and physiological studies to recognize means of attaining genetic potentials. For example, it is known in a general way that favorable growing conditions will produce a large plant with little rubber. On the other hand, "stress" brought about by cool temperatures or reduced moisture produces higher rubber percentages per plant. The optimum mix of "growth" and "stress" must be obtained for maximum production.

Up to one-fourth of the rubber is in the roots, thus it has been customary to harvest guayule by digging. Establishment of stands has been by means of producing seedlings in nurseries and transferring them to field plantations. If plantations could be established at a lower cost by direct seeding and if plants could be mowed and the rubber harvested one or more times before digging, greater economic returns would be obtained. We think these objectives are attainable but research is needed to

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bring them into practice.

While existing rubber extraction equipment and methodology have produced rubber of satisfactory quantity and quality, there is room for great improvement. The original milling equipment was designed by mining engineers utilizing "pebble mills," devices used to crush rocks to release their mineral content. Later the "jordan," a machine to break up wood fibers for the production of paper pulp, was used. Both devices can release rubber held in guayule plant cells, but research is needed to increase rubber recovery and reduce milling cost. Resins that occur along with the rubber present problems. The resins have value if they can be recovered, but they degrade rubber quality if not removed from the latex.

Guayule research is not just an economic need, it is definitely a national necessity. We learned during World War II the consequences of being without a domestic rubber supply. We must not let that happen again. Our present need for natural rubber is about 800,000 tons a year. We easily could produce 100,000 to 200,000 tons of guayule rubber yearly without serious impact on food and fiber production. On the basis of present production rates 400,000 to 800,000 acres would be needed. Incidentally we then would have the know-how and seed supplies to increase production rapidly to meet any shortages that might occur and if necessary, guayule production could be increased to meet all our rubber needs without a major reduction in

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food and fiber crops. It is reasonable to expect that through research we can double or triple the production per acre to increase not only national production, but also provide greater returns to the grower.

In summary there is an urgent need for guayule research. First, the essential need of an increased national supply of natural rubber must be met. Consumption is exceeding supplies and stockpiles are dwindling. Our national interests are in jeopardy because of possible cartels, losses to disease and the possible exegencies of war. Second, because guayule production would strengthen our economic base by reducing imports which affect balance of trade and by increasing farm production and alleviating crop surpluses.

Because of the highly dependent interrelationships of all phases of research and because of the time factor resulting from pressing needs for natural rubber, it is essential that the funding for research be sufficient to provide a comprehensive research program aimed at the earliest possible solution of problems now faced in making guayule an economic crop to ensure its continuing contribution to the welfare of the United States.

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